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CITY OF SUNNYVALE

MASTER PLAN AND PRIMARY TREATMENT DESIGN

TECHNICAL MEMORANDUM

SOLIDS TREATMENT:
MASTER PLAN

FINAL
May 2014

in association with

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CITY OF SUNNYVALE

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1.0 INTRODUCTION

This technical memorandum (TM) presents an analysis and selection of process alternatives for solids treatment at the City of Sunnyvale's (City's) Water Pollution Control Plant (WPCP). The selected solids treatment processes proposed for the WPCP are based on providing the needed improvements through buildout (2035) to meet the City's goals and objectives. The recommendations presented herein are an update to and expansion of the recommendations included in the City's WPCP Strategic Infrastructure Plan (SIP).

The evaluation was completed using a two-step process: (1) a one-week internal peer review was held on September 9th through 12th, 2013 which was attended by process experts from the Carollo/HDR team and (2) a two-day workshop on October 14th and 15th, 2013, during which time the Carollo/HDR team presented the recommended liquid and solids treatment processes to the City staff. The key findings and recommendations developed for the solids treatment process are summarized in this TM, as well as in the October workshop meeting minutes and presentation slides included in Appendix A.

2.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

The key findings and recommendations for the solids treatment process include:

- All process facilities required for solids treatment should be designed to accommodate the 2035 maximum month (MM) load generated from the primary and secondary treatment processes. The 2035 MM Load is projected to be 46,000 pounds per day (ppd) of total suspended solids (TSS) and 40,000 ppd of volatile suspended solids (VSS). Equipment would be sized and/or installed in phases to accommodate flows as they increase. Equipment sizing and phasing would be determined as part of the Basis of Design to be completed as part of the Master Plan.
- Thickening:
  - Thicken primary sludge in the new primary sedimentation basins (PSTs).
  - Thicken secondary waste activated sludge (WAS) with rotary drum thickeners (RDTs).
  - Implement an automated sludge feed system to separately feed thickened primary sludge (PS) and thickened waste activated sludge (TWAS) to each digester in operation.
  - Operate the thickening facility 24 hours a day and 7 days a week.
  - Install two RDTs (one duty and one standby) as part of the initial phase of thickening to accommodate the 2025 MM load. Given the incremental size of

RDT units available, two RDT units (one duty and one standby) would have enough capacity to accommodate the 2035 MM Load.

- Co-locate the thickening facility with the dewatering facility inside a building.
- Provide site space adjacent to the thickening facility for thickening polymer storage and odor control facilities.
- Provide site space adjacent to the digesters for thickened and un-thickened waste activated sludge (WAS) storage, as well as for un-thickened primary/WAS sludge. The latter would be required if co-thickening primary/WAS sludge were required (as would be the case if phosphorous removal were implemented).

- Digestion:
  - Continue operating the existing mesophilic digestion process until there is a driver to produce Class A sludge. Digester Nos. 3 and 4 were recently rehabilitated and Digester Nos. 1 and 2 are currently being rehabilitated. Improvements to all four digesters include converting from a floating cover to a fixed cover; upgrading the digester heating and heat recovery systems; and converting the digester mixing system to a pumped mixing system.
  - Expand the existing digester facility as needed to provide adequate process reliability and efficiency and to accommodate future sludge flows. It is anticipated one additional digester will be required between 2026± and 2035±, with the implementation impacted by future flows and loads as well as the potential split flow operation.
  - Provide site space for one additional digester that is the same size as Digester No. 4 (about 1.0 million gallons [MG]).
  - As included in the thickening recommendations, implement an automated sludge feed system to continuously and separately feed thickened PS and TWAS to each digester in operation.
  - Allocate WPCP site space for fats, oils, and grease (FOG) and emulsified (liquid) food handling facilities.
  - Allocate WPCP site space to implement either pre-processing or post-processing sludge options to meet Class A requirements for at least of portion of the biosolids produced.
  - Continue to evaluate solids production and digestion values as part of the transition to the new PST facility and secondary treatment facility. These values include, but are not limited to: sludge production (lb/day), sludge feed thickness (percent solids), and VSS destruction (%).

- Dewatering:
  - Dewater digested sludge with screw presses.

- Install three screw presses (two duty and one standby) as part of the initial phase of dewatering to accommodate the 2025 MM Load. Install one additional screw press as part of the second phase of dewatering to accommodate the 2035 MM load.
- Operate the dewatering facility 24 hours a day and 5 days a week.
- Co-locate the dewatering facility with the thickening facility inside a building. Cross-tie the WAS piping to the dewatering screw presses for digestion capacity backup.
- Provide site space adjacent to the dewatering facility for: dewatering polymer storage; solids handling odor control facilities; digested sludge storage; and dewatered cake conveyance, storage and truck loading.
- When the new dewatering facility is implemented, provide a digested sludge storage tank upstream of the dewatering process for digested sludge equalization. It is recommended the digested sludge storage tank provide two days of digested sludge storage during 2035 MM Load, which would result in a storage capacity of approximately 0.3 MG.
- Provide dewatered cake conveyance, cake storage, and truck loading facilities to convey, store and offload dewatered cake. It is recommended the cake storage hopper provide one day of cake storage during 2035 MM Load, which would result in a storage capacity of approximately 200 CY.
- The dewatering facilities should be designed with the flexibility to implement centrifuges should biosolids drying (i.e., drier or gasification) be required to produce Class A biosolids. The decision to move to centrifuges could come at the end of the useful life of the screw presses or when biosolids drying is required (~2030± - 2035±).

- Odor Control:
  - Provide a single, package-type bioscrubber system to treat odors collected at the solids handling facilities, including the thickening, dewatering and cake storage facilities.
  - Locate the odor control system near the thickening and dewatering building to simplify the odor ducting design.
  - Include the following provisions to adequately contain odors generated at the solids treatment facilities and exhaust them to a bioscrubber system:
    - Cover and enclose the RDTs, screw presses, digester sludge storage tank, and cake loading facilities.
    - Completely seal the digester sludge storage tank and extract any biogas that may be produced in the tank with a gas piping system that is connected to the cogeneration system. The gas piping system would be similar to that of the existing digesters.

- * Install exhaust fans to extract enough air from the covered and enclosed RDTs, screw presses, and dewatered cake storage facilities to prevent fugitive emissions and convey the extracted air to the odor control system.
- * Install a ventilation system for areas that will be accessed by personnel to provide sufficient air changes required for worker safety.

2.1 Split Flow Treatment Considerations

The analysis conducted in the October 2013 workshops and summarized herein was based on replacing the existing secondary treatment process (an oxidation pond system) with a new secondary treatment process (i.e., conventional activated sludge or MBR) to meet anticipated nutrient removal limits. To meet the anticipated limits, the City would implement the first stage of the new secondary treatment plant by the end of 2023±.

As part of the Master Plan, the City is considering implementation of a split-flow secondary treatment alternative. The split flow alternative allows for a phased approach to the secondary treatment improvements to provide more flexibility in dealing with future regulatory uncertainties. If the split-flow treatment alternative is implemented, the findings and recommendations for the solids treatment processes would be different based on the secondary process selected.

If split-flow treatment were implemented, the WAS load to the digesters would be lower because a portion of the flow would be treated by the oxidation ponds. Solids generated by the oxidation pond process would be treated in the ponds and remain in the ponds. As a result, the required solids thickening, digestion and dewatering capacity would be lower than summarized herein. Projected solids loads and digester capacity demands under split flow treatment are summarized in Appendix C.

The findings and recommendations for solids treatment would be the same as those listed above; however, the equipment and facilities would be phased in gradually as needed. The recommended phasing for the major equipment and facilities is as follows:

- Thickening:
  - No change. Implement the same facilities required for a full, new secondary treatment process. Two RDTs would be required (one duty + one standby) when split-flow treatment is implemented. Given the incremental size of RDT units available, two RDT units (one duty and one standby) would have enough capacity to accommodate the 2035 MM Load under split flow treatment and the 2035 MM Load under full, new secondary treatment.

- Digestion:
  - Implementation of an additional digester would be delayed. If a feed solids thickness of 4 percent could be achieved, one additional digester would not be required until full, new secondary treatment is implemented. If a feed solids

thickness of 3.5 percent could be achieved, the additional digester would be required around 2030±.

- Dewatering:
  - Phase implementation of screw presses. Install three screw presses (two duty and one standby) when split-flow treatment is implemented. Install one additional screw press (three duty and one standby total) when full, new secondary treatment is implemented.

2.2 Phosphorous Removal Considerations

As described in the SIP Validation TM, phosphorous removal may be required in the future. As described in the Secondary Treatment TM, the City may implement chemically enhanced primary clarification (CEPT) to provide phosphorous removal, a process which includes adding chemicals (ferric and polymer) to the PSTs. In addition, the City may add methanol to the secondary treatment process. The addition of these chemicals will increase the amount of primary sludge and WAS generated by the treatment process. As a result, the required thickening, digestion and dewatering capacity would be higher than summarized herein. Projected solids loads and digester capacity demands are summarized in Appendix C.

If chemical addition is selected for phosphorus removal, it is recommended the RDT facility be expanded and operated to co-thicken PS and WAS to achieve a digester feed solids thickness of 4 to 5 percent solids. At this feed thickness, additional digester capacity would not be required to treat the additional solids generated by phosphorous removal. Only one additional digester, the size of Digester No. 4 would be required (as recommended for operation without phosphorous removal). At a feed thickness of about 4.5 percent, about 15 percent of the firm digester capacity would be available to treat FOG and food waste.

One additional RDT would be required to provide enough capacity to co-thicken PS and WAS (two duty and one standby total). An un-thickened sludge storage tank would be required to blend PS and WAS upstream of the RDTs to provide a more homogenous sludge feed to the RDTs. It is recommended the un-thickened sludge storage tank provide approximately 8 hours of sludge storage during 2035 MM Load, which would result in a storage capacity of approximately 0.13 MG. Given this, it is recommended that site space be provided to accommodate three RDTs and an un-thickened PS/WAS storage tank.

One additional screw press would be required (three duty and one standby total). Alternatively, centrifuges could be implemented instead of screw presses to minimize the overall footprint of the dewatering facility. Two duty and one standby centrifuge could be implemented and would require about the same space as three screw presses. Digested sludge storage would be about the same size; the dewatered cake storage would need to be a little larger (approximately 240 CY).

3.0 SIP RECOMMENDATIONS

The SIP included solids treatment recommendations for two plant scenarios: 1) renovating and optimizing the existing plant and 2) replacing the existing plant with a predominantly new plant, such as a conventional activated sludge plant or membrane bioreactor (MBR) plant. Recommendations for the latter scenario are most relevant given the City has decided to implement a new plant. The SIP recommendations for solids treatment to be implemented with a new plant are summarized herein.

Table 1 summarizes how the Master Plan recommendations compare with the SIP recommendations. The SIP recommendations are described further in the following sections and discussed in greater detail in the Plant Replacement Alternatives Goals and Objectives TM of the SIP.

Table 1 Comparison of Master Plan and SIP Recommendations
Master Plan and Primary Treatment Design
City of Sunnyvale

Process/ Technology	Strategic Infrastructure Plan (SIP) (2011)	Master Plan (2014)
Thickening	• Co-thicken primary and secondary sludge with rotary drum thickeners.	• Thicken primary sludge in primary sedimentation tanks. • Thicken waste activated sludge (WAS, or secondary sludge) with RDTs. • Operate RDTs continuously. • Implement an automated sludge feed system to separately feed thickened PS and thickened WAS (TWAS) to digesters.
Un-thickened Sludge Storage	• Provide un-thickened PS and un-thickened WAS storage to provide blended PS/WAS sludge feed to RDTs.	• No storage required given PS would be thickened in the PSTs and the RDTs would be operated continuously.
Thickened Sludge Storage	• Provide storage of thickened PS and TWAS.	• No storage required given PS and WAS would be fed separately to digesters and the RDTs would be operated continuously.

Table 1	Comparison of Master Plan and SIP Recommendations Master Plan and Primary Treatment Design City of Sunnyvale	
Process/ Technology	Strategic Infrastructure Plan (SIP) (2011)	Master Plan (2014)
Digestion	• Upgrade existing digesters to improve digester operation and efficiency. • Convert existing digestion process to a temperature phase anaerobic digestion (TPAD) process to produce Class A biosolids. • Reserve site space to double the existing digester capacity to provide enough capacity to digest community organic waste (food waste).	• Upgrade digesters to improve digester operation and efficiency (upgrades currently underway). • Continue operation of existing mesophilic digestion process to produce Class B biosolids. • Provide site space for one additional digester that is the same size as Digester No. 4 to accommodate future loads. • Implement automated sludge feed system to continuously and separately feed PS and WAS to each digester. • Use excess digester capacity to treat fats, oils, and grease (FOG) and emulsified (liquid) food waste. Allocate WPCP site space for FOG and emulsified food handling facilities. • Allocate WPCP site space to provide for either pre-processing or post-processing sludge options to meet Class A requirements for at least of portion of the biosolids produced.
Digested Sludge Storage	• Provide storage.	• Provide digester sludge storage tanks that provides two days of digested sludge storage at 2035 maximum month (MM) Load.
Dewatering	• Dewater digested sludge with screw presses or centrifuges depending on City's preference for day-shift only operation.	• Dewater digested sludge with screw presses (with provisions to accommodate centrifuges in the future).
Dewatered Cake Storage	• No storage provided	• Provide cake hopper that provides one day of dewatered cake storage at 2035 MM Load.

3.1 Solids Thickening

Primary sludge is currently thickened in the existing PSTs, before being pumped to the digesters for stabilization. Secondary sludge, which is generated in the oxidation ponds, currently settles to the bottom of the oxidation ponds where it degrades and compacts over time.

When the existing secondary treatment process (an oxidation pond system) is replaced with a new secondary treatment process, the SIP recommended RDTs be implemented to thicken primary and secondary sludge simultaneously, which is known as co-thickening. The SIP also stated the primary sludge and secondary sludge could be thickened separately. RDTs were recommended for thickening over dissolved air floatation tanks (DAFTs), gravity belt thickeners (GBTs) and thickening centrifuges because this technology was determined to have the lowest life cycle cost.

3.2 Digestion

Primary sludge is currently digested in primary anaerobic mesophilic digesters. Digested sludge is then sent to a secondary digester where it is decanted before it is pumped to the dewatering beds for dewatering. There are four existing digesters. Each can be operated as a primary digester for digestion or as a secondary digester for decanting. The City currently operates one digester at a time for decanting and regularly rotates which digester is used for decanting. The existing digestion system produces Class B biosolids, as defined by the US Environmental Protection Agency (USEPA).

The SIP recommended two stages of improvements to the digestion system. The first stage would include upgrades to the existing mesophilic digesters to improve digester operation and efficiency (the last phase of these improvements should complete in late 2015). The second stage would include converting the existing digestion process to a temperature phase anaerobic digestion (TPAD) process to produce Class A biosolids. The drivers to move to Class A biosolids were not discussed.

The TPAD process includes operating thermophilic and mesophilic digesters in series. The existing mesophilic digesters would be upgraded to allow for operation at mesophilic or thermophilic temperatures. One or two digesters would be operated at thermophilic temperatures and the subsequent digesters would be operated at mesophilic temperatures. Although the TPAD process has a higher energy cost, life cycle cost and resource consumption than mesophilic digestion, TPAD was recommended because it can produce Class A biosolids. TPAD was recommended over a Cambi thermal hydrolysis process, another process that can produce Class A biosolids, because it was determined it would have a lower life cycle cost.

As part of the Modified SIP Site Plans for Discussion at the December 14 Peer Review Workshop TM of the SIP, it was recommended the City reserve site space to double the existing digester capacity. This was recommended to meet the City's interest in the possibility of additional processing of other community organics that currently flow to the SMaRT Station, which is adjacent to the WPCP (no detailed projections were developed for this recommendation). It was recommend the City also reserve site space for the additional gas treatment/ and or combined heat and power facilities to beneficially use the additional digester gas that would be produced due to processing the additional organic waste.

3.3 Solids Dewatering

Digested sludge is currently dewatered using drying beds comprised of gravity drainage filter panels. After the sludge is dewatered, it is transferred to a paved final drying area for solar drying. After solar drying, the sludge is hauled off site for placement in the WPCP sludge monofill, reused as landfill cover material or applied to land as a soil supplement.

The SIP recommended implementing screw presses to dewater digested sludge, when the new secondary plant is implemented. Screw presses were recommended over centrifuges and belt filter presses (BFPs) because the technology would have a lower life cycle cost. The SIP update acknowledged that centrifuges would be desirable if the cost to haul and beneficially use/dispose of biosolids increased, given centrifuges can produce a drier cake, which equates to lower hauling and disposal costs. Centrifuges would also be desirable if the City wanted to have day-shift only operation for dewatering, given centrifuges have much higher solids processing capacity than screw presses.

4.0 REGULATORY AND TECHNOLOGY CONSIDERATIONS AND IMPLICATIONS

Biosolids regulatory considerations and implications are described in the Regulatory Framework TM of the SIP. These considerations and implications were revisited and updated as part of the master planning process in order to develop and evaluate solids treatment alternatives. As discussed in the SIP Validation TM of the Master Plan, the following assumptions regarding biosolids disposal regulations should serve as the basis of planning:

- The disposition of the solids in the oxidation ponds will be subject to the continued use of the ponds for treatment. Solids started accumulating in the ponds in the 1960s, however recent testing has shown that that settled material would not be classified as toxic. The City has recently contracted with Synagro to dredge solids from the ponds on an annual basis to reduce the inventory in an attempt to maintain pond treatment capacity.
- There are no near-term (10+ years) drivers for producing Class A sludge (no apparent federal or state regulations anticipated).
- Because of future changes in disposal opportunities (i.e., ability to use biosolids as alternative daily cover in landfills), the City will need to develop a more diversified portfolio for beneficial use/disposal. This could include: 1) utilizing land application and alternative daily cover (ADC) as long as possible; and 2) continued monitoring of the progress of regional alternatives and developing dewatering technologies for diversification.
- All potential beneficial use/disposal options include the need for thickening, digestion and dewatering as part of the solids disposal process train (see Figure 1).

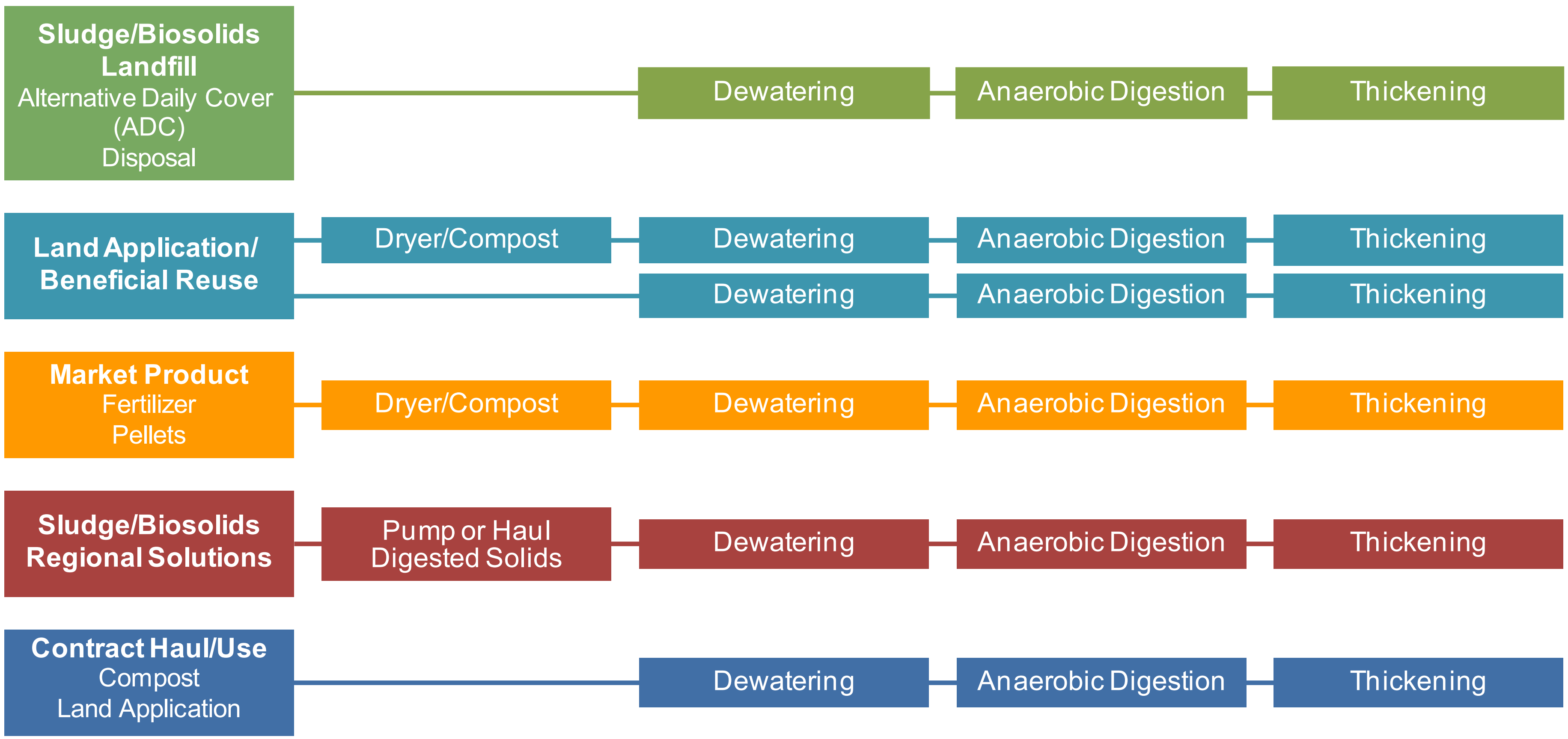

Figure 1
SOLIDS BENEFICIAL USE/DISPOSAL AND TREATMENT OPTIONS
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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- Space should be allocated on the WPCP site to provide for either pre-processing or post-processing options to meet Class A requirements for at least of portion of the biosolids produced. Flexibility should be provided in the thickening and dewatering facilities designs to accommodate these options. Further discussion of potential pre-processing or post processing options can be found in a summary memorandum in Appendix B.
- Because of the size of the WPCP and associated scalability/operational complexity issues associated pre-processing or post-processing facilities, implementation of either alternative should be carefully considered. The City would likely be better served in evaluating regional biosolids alternatives when the ability to utilize land-disposal options becomes too costly.

5.0 THICKENING

The primary purpose of sludge thickening at a wastewater treatment plant is to reduce the volume of sludge that needs to be digested, dewatered and ultimately hauled offsite. This reduces the required capacity of the digestion and dewatering facilities, as well as hauling costs.

This section summarizes the recommended preliminary design criteria for the thickening process, an evaluation of technology alternatives, implementation and site considerations and recommendations for the new thickening process.

5.1 Background

This section summarizes the key design criteria considered and established for the thickening process in order to develop and evaluate thickening technology alternatives.

5.1.1 Separate Thickening or Co-thickening of Primary Sludge and WAS

As part of the primary treatment alternatives analysis, two PS thickening alternatives were considered:

- **Alternative 1 – Co-thickening:** Construct a co-thickening facility under the near-term Primary Treatment Facility project to co-thicken primary sludge and waste activated sludge (WAS). (Note, this facility would thicken primary sludge only until the secondary process is implemented.)
- **Alternative 2 – Separate Thickening:** Thicken primary sludge in the PSTs and construct a thickening facility to thicken WAS.

Alternative 2 – Separate Thickening was recommended for implementation. Separate thickening minimizes the capital cost of the near-term Primary Treatment Facility project because it defers the need for a thickening facility until the secondary treatment improvements are implemented. Separate thickening was also considered to be more compatible with the future secondary treatment process, because thickening PS in the PSTs will supply more carbon to the secondary treatment process, which is required to achieve full biological nutrient removal. For additional information on this evaluation, refer to the Primary Treatment TM.

Thickening alternatives and recommendations presented herein are based on implementing separate PS and WAS thickening. Alternatives and recommendations for WAS thickening are presented herein. Recommendations for thickening PS in the PSTs are included in the Primary Treatment TM.

5.2 Technologies Considered

5.2.1 Alternative Technologies

To select the best available technology for the proposed thickening facility, a number of technologies were initially evaluated and discussed with City staff, including:

- Dissolve air flotation thickeners (DAFTs).
- RDTs and the similar disc thickener.
- Gravity belt thickeners (GBTs).
- Thickening centrifuges.

5.2.1.1 Dissolved Air Flotation Thickeners

DAFTs are tanks that introduce fine air bubbles to the sludge in order to separate sludge solids from the liquid stream and thicken the sludge. WAS from the secondary process would be continuously fed to the DAFT. In the DAFT, the WAS would be mixed with polymer and continuously aerated with fine bubbles. The bubbles would attach to the solid particles of the WAS, making them buoyant. The solid particles would float to the surface, be collected with a skimmer, and ultimately conveyed to the digestion process. The clarified effluent from the DAFT would be conveyed to the Site Waste Pump Station and pumped to the Influent Pump Station.

5.2.1.2 Rotary Drum and Disc Thickeners

RDTs consist of a flocculation development tank and a porous rotary drum screen, which is supported by a frame and enclosed with covers. Disc thickeners use a sloped perforated disc with a rotating arm in a covered tank. WAS from the secondary process would be conditioned with polymer and flocculated in the flocculation development tank. The flocculated WAS would then flow to the rotary drum screen. In the rotary drum screen, free water would drain by gravity from the flocculated WAS through the drum screen as the thickened WAS is conveyed to the discharge end of the drum. The thickened WAS would be conveyed to the digestion process. The free water would be conveyed to the Site Waste Pump Station and pumped to the Influent Pump Station. Figure 2 includes a schematic diagram and photo of an RDT.

Figure 2
ROTARY DRUM THICKENER
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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5.2.1.3 Gravity Belt Thickeners

GBTs consist of a flocculation tank and gravity belt that moves over rollers. WAS from the secondary treatment process would be conditioned with polymer in the flocculation tank and then distributed evenly across the belt. Free water would drain by gravity from the flocculated WAS through the porous belt as the WAS is conveyed to a discharge point. The thickened WAS would be conveyed to the digestion process. The free water would be conveyed to the Site Waste Pump Station and pumped to the Influent Pump Station. Figure 3 present a schematic diagram and photo of a GBT.

5.2.1.4 Thickening Centrifuges

A thickening centrifuge uses centrifugal force generated through high-speed spinning to separate the sludge solids from the liquid stream and compress the solids into thickened sludge. WAS from the secondary treatment process would be pumped into a feed tube which extends into the rotating assembly of the centrifuge. The rotating assembly would rotate at high speeds in the range of 2,500 to 2,900 rpm to create high centrifugal forces. The forces would cause the solids and liquids to separate. The separated liquid (centrate) would be collected, conveyed to the Site Waste Pump Station, and pumped to the Influent Pump Station. The separated solids (thickened WAS) would be collected and conveyed to the discharge end of the rotating assembly. The thickened WAS would be conveyed to the digestion process. Polymer is typically added to the centrifuge to optimize the thickening process. Figure 4 presents cut-away of a centrifuge.

5.3 Alternative Analysis

Table 2 summarizes how each thickened technology meets the City's evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

During the internal peer review in September and the workshop held in October 2013 it was determined that RDTs should be implemented to thicken WAS. This is consistent with the SIP recommendations. RDTs are recommended because they have a relatively low life cycle cost and relatively low resource consumption (e.g., energy and polymer use). Furthermore, RDTs are easy to operate, result in a clean working area, contain odors well, and have a compact site footprint. While the newer disc thickener was not discussed, it is similar in operation and footprint and should be considered during preliminary design for the facility.

Thickening centrifuges are not recommended because they are relatively complex technology and would have a high power cost. Although thickening centrifuges can be operated to produce thicker sludge than the other technologies, there is no driver to produce highly thickened sludge (which is discussed in further detail below in the section summarizing the digester capacity).

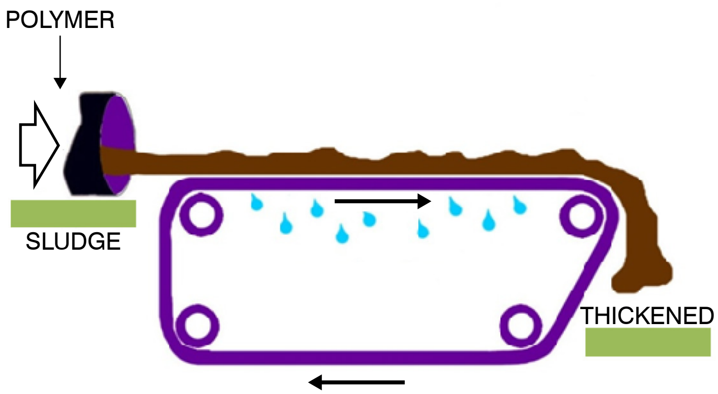

Figure 3
GRAVITY BELT THICKENER
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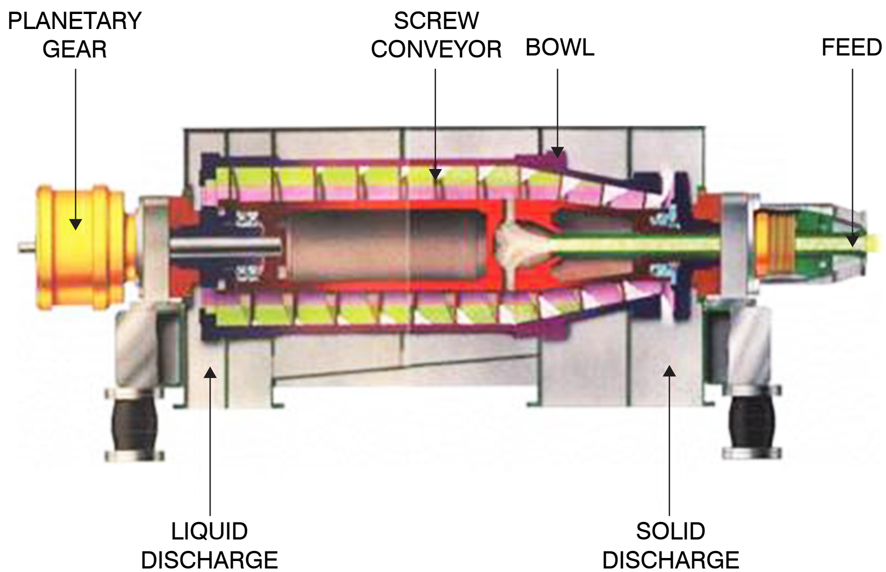

Figure 4
THICKENING CENTRIFUGE
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Table 2	Evaluation Summary of Dewatering Alternatives Master Plan and Primary Treatment Design City of Sunnyvale			
Evaluation Criteria	**Dissolved Air Flotation Thickeners**	**Rotary Drum/ Disc Thickeners**	**Gravity Belt Thickeners**	**Thickening Centrifuges**
Reliability	+	+	+	+
Ease of O&M				
Unattended Operation	+	0	0	-
Odor Containment	-	+	-	-
System simplicity	0	0	0	-
Power and Polymer Usage	-	+	0	-
Flexibility	+	0	0	+
Site Efficiency	-	0	-	+
Net Present Value	0	+	+	-

Note:
(1) Legend: + Better; 0 Neutral; - Worse.

Gravity belt thickeners are not recommended because they are not as clean as the other technologies and it is more difficult to contain the odors generated by this technology. GBTs do not offer significant cost savings over RDTs and achieve about the same solids thickness as RDTs.

Converting the existing 60-foot diameter air flotation thickeners (AFTs) to solids thickening DAFTs is not recommended. The existing AFTs are currently used to thicken and remove algae from the secondary effluent prior to filtration. Based on evaluations at similar wastewater treatment plants, the existing AFTs are considered to be oversized and inefficient for WAS thickening. The air distribution system and polymer systems would need to be modified or replaced because the air to solids ratios and polymer dosages are very different for algae and WAS thickening. In addition, the AFTs would need to be covered to contain odors, which would be more costly than odor control provisions required for RDTs. Building new DAFTs for thickening is not feasible due to limited site availability.

5.4 Implementation Considerations (Phasing)

5.4.1 <u>Phasing</u>

The entire thickening structure required for 2035 MML would be constructed in one phase as part of the secondary treatment plant improvements. Two RDTs (one duty and one standby) would be installed as part of the initial phase of thickening to accommodate the 2025 MM Load. Given the incremental size of RDT units available, two RDT units (one duty and one standby unit) would provide enough capacity to accommodate the 2035 MM Load.

5.4.2 Hours of Operation

During the internal peer review in September 2013 and the workshop held in October 2013, the intention was to operate the thickening facility during day-shifts only assuming attended operation would be required. They would be operated 5 days a week assuming the plant would be unattended over the weekend. They would be operated 7 hours per day (assuming 8-hour day shifts with one hour allocated for start-up and shut-down of thickening equipment).

It is recommended, however, that the thickening process be operated continuously – seven days per week, 24 hours per day. This is recommended for the following reasons:

- It is recommended that WAS be continuously wasted from the secondary treatment process. If the thickening facility is operated continuously, WAS could be sent directly to the RDTs and un-thickened sludge storage would not be required.
- It is recommended that WAS be fed continuously to the digesters. If WAS is fed intermittently, foaming issues may occur. If the thickening facility is operated continuously, (TWAS) could be sent directly from the RDTs to the digesters, and thickened sludge storage would not be required.
- Other facilities operate RDTs unattended.
- Fewer RDTs would be required, which would reduce the cost and site requirements of the thickening facility. If the RDTs were operated 5 days per week, 7 hours per day three RDTs (two duty and one standby) would be required.

5.4.3 Un-Thickened Sludge Storage

The SIP recommended providing one storage tank for un-thickened sludge, where un-thickened PS and TWAS would be blended prior to co-thickening. It was recommended the storage tank be equipped with a pump mixing system to keep the contents well mixed.

Based on the Master Plan analysis, un-thickened sludge storage would not be required for primary sludge given the decision to thicken primary sludge in the PSTs. As stated above, un-thickened sludge storage for WAS would not be required, given the decision to operate the thickening facility continuously.

Should there be a decision to operate the thickening facility during day-shifts only (7 days per week, 8 hours per day), un-thickened WAS storage would be required to allow continuous wasting from the secondary treatment process. If the thickening facility were to be operated during day-shifts only, it is recommended the tank be sized to provide 18 hour of un-thickened sludge storage during 2035 MM load, which results in a storage capacity of about 0.18 MG. The tank would need to be covered to contain odors, equipped with a mixing system to keep the contents well mixed, and equipped with pumps to convey the un-thickened sludge to the thickening facility.

5.4.4 Thickened Sludge Storage

Given the SIP recommended co-thickening PS and WAS, the SIP included recommendations for a blended, thickened PS/WAS storage and sludge feed system. Based on the Master Plan analysis, neither primary sludge storage nor TWAS storage would be required, given the decision to thicken in the PSTs and operate the WAS thickening facility continuously.

Should there be a decision to operate the WAS thickening facility during day-shifts only (7 days per week, 8 hours per day), TWAS storage would be required in order to continuously feed WAS to the digesters. If the thickening facility were to be operated during day-shifts only, it is recommended the tank be sized to provide 18 hours of TWAS storage during 2035 MM load, which results in a storage capacity of about 0.03 MG. The tank would need to be covered to contain odors, equipped with a mixing system and pumps provided to convey the thickened sludge to the digesters.

5.4.5 Thickened Sludge Feed System

Two thickened sludge feed system alternatives were considered:

- Blended PS/WAS Sludge Feed System.
- Separate Thickened PS and TWAS Feed System.

As stated above, the SIP recommended providing a blended, thickened PS/WAS storage tank and sludge feed system upstream of the digester facility. The primary benefit of the blended, thickened sludge storage tank is it allows operators to feed a more constant blend of primary and WAS sludge to the digesters. The storage provides a wide spot where primary sludge and WAS can equalize and blend before it is pumped to the digesters. The storage tank would need to be covered to contain odors, equipped with a mixing system, and equipped with a pumping system to convey the thickened sludge to the digesters. If this were implemented, it is recommended the thickened storage tank provide eight hours of thickened PS and TWAS storage during 2035 MM Load, which would result in a storage capacity of about 0.05 MG. This size tank is expected to provide adequate sludge blending throughout the day.

However, based on Carollo/HDR's experience, digester performance is not typically sensitive to a variable feed sludge blend of PS/TWAS provided the digesters are well mixed (i.e., the contents are turned over at least six times per day). An alternative to implementing a blended, thickened sludge storage and feed system would be to implement a digester feed system that separately feeds thickened PS and TWAS to each digester. This alternative would include pumps, piping, motorized valves, sludge density devices and flow meters. The system would be automated to feed primary sludge directly from the PSTs and TWAS directly from the thickening facility to each digester based on time or flow setpoints. With this configuration, primary sludge and TWAS would be fed to the digesters whenever either sludge is being wasted from the treatment process. As a result, the blend of primary sludge and TWAS would vary throughout the day, which as stated above should not impact digester performance if the digesters are well mixed. This alternative would be lower in cost, generate less odors, require less operator and maintenance (O&M) attention, and be easier to control.

It is recommended that an automated sludge feed system be implemented to distribute the thickened PS and TWAS to each digester. This alternative is recommended because, it is lower cost, generates less odors, requires less O&M attention, is easier to control, and controlling the feed sludge blend of PS/TWAS to digesters is not critical to digester operation.

5.5 Site Considerations

The following site considerations should be considered when determining the site layout and design of the thickening facility:

- The thickening facility would be housed in a building and would be co-located with the dewatering facility. In addition to the thickening equipment, the building should house electrical, control and thickening polymer facilities.
- Site space adjacent to the thickening facility should be provided for thickening polymer storage and odor control facilities.
- The thickening facility would include provisions for odor control, including containment and treatment for foul air within the RDTs.
- The thickening polymer system would be contained within the thickener building. Polymer storage tanks would be contained outside the building under a canopy, to minimize the building footprint.
- Adequate truck and crane/equipment access must be provided for operations and maintenance.
- Provide site space adjacent to the digesters for thickened and un-thickened WAS storage as well as for co-thickened Primary/WAS sludge.

5.6 Findings/Recommendations

The findings and recommendations for the thickening process include:

- Thicken primary sludge in the new PSTs.
- Thicken secondary waste activated sludge (WAS) with RDTs.
- Implement an automated sludge feed system to separately feed thickened PS and thickened WAS (TWAS) to each digester in operation.
- Operate the thickening facility 24 hours a day and 7 days a week.

- Install two RDTs (one duty and one standby) as part of the initial phase of thickening to accommodate the 2025 MM load. Given the incremental size of RDT units available, two RDT units (one duty and one standby) will have enough capacity to accommodate the 2035 MM Load.
- Co-locate the thickening facility with the dewatering facility inside a building.
- Provide site space adjacent to the thickening facility for thickening polymer storage and odor control facilities.
- Provide site space adjacent to the digesters for thickened and un-thickened WAS storage, as well as for un-thickened primary/WAS sludge. The latter would be required if co-thickening primary/WAS sludge were required (as would be the case if phosphorous removal were implemented).

6.0 DIGESTION

The digestion process provides sludge stabilization. It treats the solids generated by the liquid treatment process by converting them to a stable product (one that will not readily decay) that can be beneficially used or disposed of. The digestion process reduces the pathogen content, odor potential, and vector attraction of the sludge, all of which increase the usability and disposability of the sludge. The digestion process also generates biogas which is used for plant energy.

This section summarizes the capacity of the existing digestion facility at 2025 and 2035 MM flows and loads and summarizes recommendations to increase digester capacity and redundancy, as well as provide flexibility to meet anticipated near-term and long-term biosolids regulations.

6.1 Background

Given there are no near-term (10+ years) drivers for producing Class A sludge, it is recommended the City continue using the existing mesophilic digestion process and provide additional capacity as needed to accommodate future sludge flows. The primary focus of the digestion treatment alternatives analysis performed for the Master Plan and summarized herein includes: (1) determining how much and when additional digester capacity may be required; (2) the feasibility of digesting fats, oil and grease and food wastes to increase digester gas production; and (3) allocating site space to provide for either pre-processing or post-processing options to meet Class A requirements for at least portion of the biosolids produced.

6.2 Digestion Capacity Analysis

Process capacity for the existing digestion facility is presented in this section based on the projected solids flows and loads and recommended design criteria.

6.2.1 Solids Flow and Load Projections

When the new secondary treatment process is implemented, both thickened primary sludge (PS) and TWAS will be sent to the digestion facility. To determine the future flows and loads that will be sent to the digester facility, sludge flows and loads at the projected 2025 and 2035 maximum month flow (MMF) were developed. The sludge flows and loads were developed using a BioWin model and the projected plant influent flows and loads presented in the Master Plan Flow and Loads TM.

Table 3 presents the projected solids flows and loads. These values were used as the primary basis for the development and evaluation of the digestion facility improvements.

Table 3 Projected Flow and Load to Digesters
Master Plan and Primary Treatment Design
City of Sunnyvale

Parameter (1)	2025 ADMMF	2035 ADMMF
Primary Sludge (PS)		
PS TSS, ppd	26,000	28,000
PS VSS, ppd	23,000	25,000
WAS Activated Sludge (WAS)		
WAS TSS, ppd	17,000	18,000
WAS VSS, ppd	14,000	15,000
Total Feed Solids to Digestion		
Total TSS load to digesters, ppd	42,000	45,000
Total VSS load to digesters, ppd	37,000	39,000
Total flow to digesters, gpd	143,000	154,000

Notes:
(1) TSS = total suspended solids; VSS = volatile suspended solids.
(2) Solids flow to the digesters is based on an average combined PS and WAS solids concentration of 3.6 percent and 98% capture of WAS during thickening process.

The solids loads presented above are greater than those included in the SIP. The SIP developed solids load projections for primary sludge, but not for WAS. The SIP projected the 2035 average annual primary sludge load to the digesters would be 13,200 ppd (as presented in the SIP Solids Loads TM). For the Master Plan, this load was projected to be about 22,700 ppd or about 70 percent greater than the SIP projection. The projected loads are 70 percent greater because the master plan assumed higher plant influent loads than the SIP. It also appears that the SIP load projections are based on a lower removal efficiency of primary sludge in the primary sedimentation tanks (PSTs), which would result in less primary sludge sent to the digesters.

6.2.2 Existing Digester Facilities

Table 4 summarizes the size and volume of the existing digesters. As described above, each digester can be operated as a primary digester for digestion or as a secondary digester for decanting the digested sludge prior to dewatering. The City currently operates one digester at a time for decanting and regularly rotates which digester is used for decanting.

Table 4 Summary of Existing Digester Capacity
Master Plan and Primary Treatment Design
City of Sunnyvale

Digester	Diameter, ft	Side Water Depth, ft	Volume, MG
Digester Nos. 1, 2 and 3	50	33	0.6 each
Digester No. 4	70	33	1.0
Total Volume			2.8
Total Volume with Largest Unit out of Service			1.8

For the purpose of the capacity analysis, it was assumed all four digesters would be used as primary digesters and digested sludge would be decanted in a new digester sludge storage tank. In addition to providing decanting of digested sludge, the new digester sludge storage tank would provide a necessary wide spot in the system, where digested sludge could be stored when the dewatering process is not in operation.

6.2.3 Design Criteria

Digester capacity is primarily governed by two design parameters: volatile solids loading rate (VSLR) and hydraulic residence time (HRT). Table 5 presents the recommended design and redundancy criteria in terms of volatile solids loading rate (VSLR) and hydraulic residence time (HRT).

Table 5 Recommended Design Criteria for Anaerobic Digestion
Master Plan and Primary Treatment Design
City of Sunnyvale

Design Criteria (1, 2, 3)	Flow/ Load Condition	Redundancy Criteria
Volatile Solids Loading Rate ≤ 0.12 lbs VS/cf/day	ADMMF	Largest digester out of service
HRT ≥ 15 days	ADMMF	Largest digester out of service

Notes:

(1) A range of design values for volatile solids loading rate have been provided in various design manuals. The WEF Manual of Practice No. 8 recommends a design sustained peak loading rate of 0.12 to 0.16 lbs VS/cf/day with an upper limit of 0.20 lbs VS/cf/day. The design value of 0.12 lbs VS/cf/day is recommended to maintain stable PS/TWAS digester operation under all operating conditions. Higher loadings could be handled if they are the result of adding readily digestible FOG.

(2) Minimum HRT of 15 days is required by EPA's Standards for the Use or Disposal of Sewage Sludge (40 CFR Part 503) as a Process to Significantly Reduce Pathogens (PSRP).

(3) While an HRT of approximately 10 days is required to prevent washout of methane-producing microorganisms inside the digester at mesophilic temperatures (95 degrees F), Metcalf and Eddy recommends a design HRT of 15 to 20 days to maintain stable digester operation under all operating conditions.

The existing digesters were originally designed to operate at a VSLR of 0.072 lbs VS/CF/day. From 2007 to 2012, the digesters were operated at an average VSLR of 0.044 lbs VS/CF/day and peak VSLR of about 0.11 lbs VS/CF/day. The City recently made improvements to the heating and mixing systems of Digester Nos. 3 and 4, and is currently making similar improvements to Digester Nos. 1 and 2. With these improvements, the digesters could potentially be operated at a higher VSLR of 0.15 – 0.18 lb VS/CF/day. These operating ranges are consistent with other facilities, which have heating and mixing systems that are similar to those being implemented at the WPCP.

It is important to consider the digesters are currently used to treat primary sludge only. They will be used to digest both primary and secondary sludge when the existing secondary treatment process (oxidation pond system) is replaced with a new secondary treatment process (i.e., conventional activated sludge or membrane bioreactors). Given secondary sludge is more difficult to digest than primary sludge, it was assumed for the purpose of planning that the digesters could be operated at a VSLR of 0.12 lbs.

6.2.4 Capacity of Existing Facilities

Table 6 summarizes the VSLR and HRT of the existing facilities for the future MML. As summarized in Table 6, the existing digestion facility does not have enough capacity to provide the recommended design HRT of 15 days and VSLR of 0.12 lb/CF/day, with one digester out of service at the projected 2025 MM load flows. With one digester out of service at the projected 2025 MM load flows, the existing facility would have a VSLR of 0.16 VS/CF/day (too high) and an HRT of 12 days (too low). In 2035, the projected loads are greater and these operating values are worse. As a result, additional digester capacity will be required to treat the projected 2025 MM load and subsequent future loads.

Table 6 VSLR and HRT of Existing Digesters at Future Max Month Conditions
Master Plan and Primary Treatment Design
City of Sunnyvale

Operating Scenario	2025 MM Load	2035 MM Load
Volatile Solids Loading Rate (VSLR), Lb VS/cf/day		
All Digesters in Service (2)	0.11	0.12
Largest Digester Out of Service	0.16	0.18
Hydraulic Residence Time (HRT), days (2)		
All Digesters in Service (3)	18	17
Largest Digester Out of Service	12	11

Notes:

(1) Assumes a feed sludge thickness of 3.5%.
(2) Assumes PS and TWAS is fed continuously to digesters (24 hours per day, 7 days per week).
(3) Assumes existing Digester Nos. 1, 2, 3 and 4 are in operation.

A sensitivity analysis was performed to determine the impact of the sludge feed thickness on the required digester capacity. Figure 5 summarizes the digester capacity required to achieve an HRT of 15 days for varying sludge feed thickness. With the implementation of the recommended PSTs and WAS thickening facilities, the digester feed sludge is expected to range from 3 to 4 percent solids. As shown in Figure 5, at 3 percent feed sludge thickness, approximately 2.8 MG of digester capacity would be required to treat the 2035 MM Load. At 4 percent feed sludge thickness, approximately 2.1 MG would be required. It is important to note, this sensitivity analysis is based on achieving an HRT of 15 days. If an HRT of 20 days were desired to provide additional redundant capacity, the required digester volume would be greater. Given the existing digesters have a total volume of 1.7 MG with the largest unit out of service, an additional 0.4 – 1.1 MG of digester capacity is required to achieve a 15-day SRT with a digester feed of 3 to 4 percent solids. Even more digester capacity would be required to achieve a 20-day SRT.

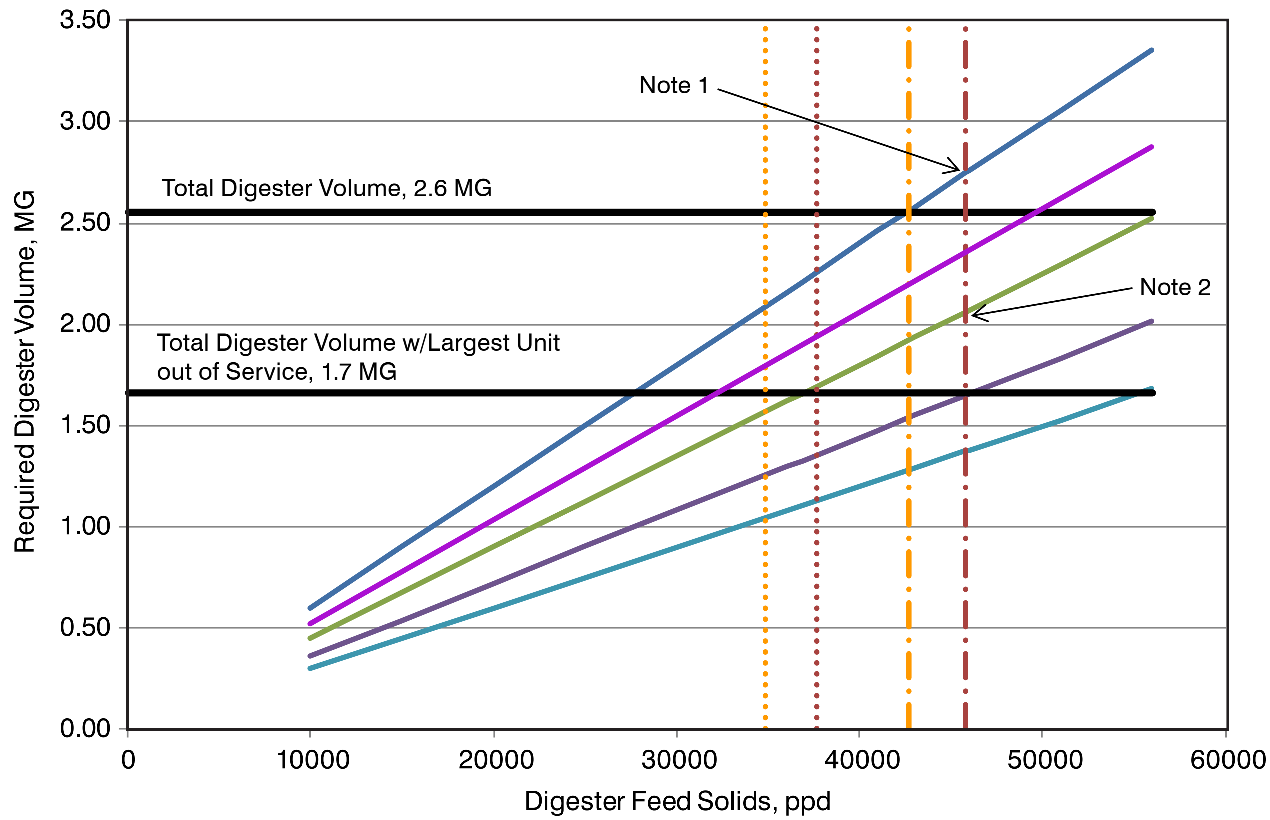
A sensitivity analysis was performed to determine the impact of the VSLR criteria on the required digester capacity. Figure 6 summarizes the digester capacity required for varying VSLRs. As shown in Figure 6, at a VSLR of 0.12 lbs VS/CF/day, approximately 2.5 MG of digester volume would be required to treat the 2035 MM Load. At a VSLR of 0.15 lbs VS/CF/day, approximately 2.0 MG would be required. Given the existing digesters have a total volume of 1.7 MG with the largest unit out of service, an additional 0.3 – 0.8 MG of digester capacity is required to achieve a VSLR of 0.12 – 0.15 lbs VS/CF/day.

These sensitivity analyses were reviewed and discussed during the September 2013 peer-review. Based on the results of this sensitivity analyses it was determined an HRT of 15 days and VSLR of 0.12 VS/CF/day were conservative design criteria and appropriate for planning purposes. Although some facilities use a 20-day HRT for planning, it was determined a 15-day HRT was conservative enough given the assumed sludge feed thickness of 3 to 4 percent solids is relatively conservative based on industry experience and standards.

6.2.5 Recommended Capacity Additions

It is recommended the City use the following design criteria for the purpose of planning for the ultimate digester capacity and site space required to produce Class B biosolids through anaerobic digestion. The recommended design criteria should be met during 2035 MM Load and with the largest digester out of service:

- 15-day HRT.
- 3.5% feed sludge thickness.
- VSLR of 0.12 lbs VS/CF/day.



Notes:

(1) At 3% feed sludge thickness, about 2.8 MG digester volume required in 2035.

(2) At 4% feed sludge thickness, about 2.1 MG digester volume required in 2035.

* TS = Total Solids; MML TS = Maximum Month Load Total Solids; AAL TS = Average Annual Load Total Solids.

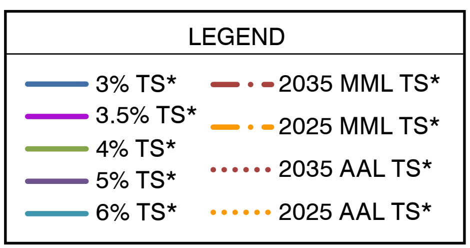


Figure 5

REQUIRED DIGESTER VOLUME FOR 15-DAY HRT AT VARYING FEED SLUDGE THICKNESS

SOLIDS TREATMENT

MASTER PLAN AND PRIMARY TREATMENT DESIGN

CITY OF SUNNYVALE

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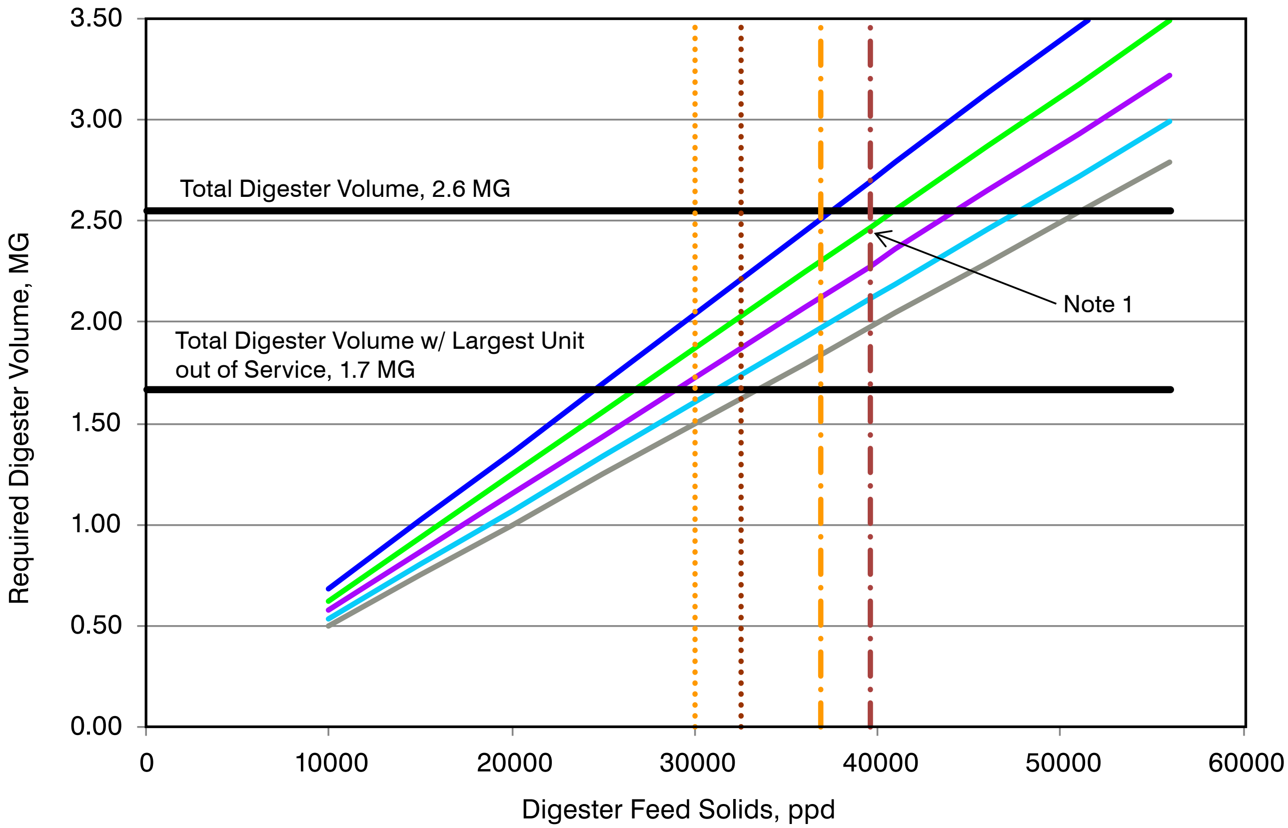

Notes:
(1) At a VSLR of 0.12 lb VS/CF/day, about 2.5 MG of digester volume required in 2035.
* MML VS = Maxmimum Month Load Volatile Solids; AAL TS = Average Annual Load Total Solids.

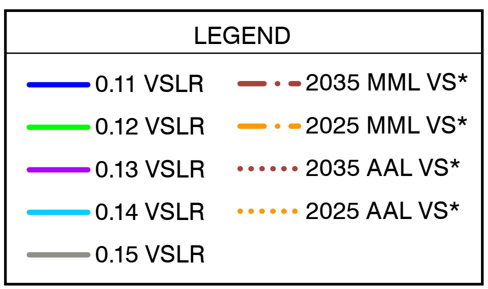

Figure 6
REQUIRED DIGESTER VOLUME AT VARYING VOLATILE SOLIDS LOADING RATE (VSLR)
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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Given this criteria, it is recommended the City plan to add one additional digester the same size as Digester No. 4. It is recommended the new digester be the same size as Digester No. 4 to simplify operation of the digester facility (e.g., flow splitting, redundancy, etc.). Table 7 summarizes the size and volume of the recommended future digester facility. Table 8 summarizes the HRT and VSLR that would be achieved at 2025 and 2035 MM loads.

Table 7 Summary of Recommended Digester Capacity
Master Plan and Primary Treatment Design
City of Sunnyvale

Digester	Diameter, ft	Side Water Depth, ft	Volume, MG
Digester Nos. 1, 2 and 3	50	33	0.6 each
Digester No. 4	70	33	1.0
New Digester No. 5	70	33	1.0
Total Volume			3.8
Total Volume with Largest Unit out of Service			2.8

Table 8 VSLR and HRT of Future Digesters at Future Max Month Conditions
Master Plan and Primary Treatment Design
City of Sunnyvale

Operating Scenario	2025 ADMMF	2035 ADMMF
Volatile Solids Loading Rate (VSLR), Lb VS/cf/day		
All Digesters in Service (2)	0.07	0.08
Largest Digester Out of Service	0.10	0.11
Hydraulic Residence Time (HRT), days		
All Digesters in Service (2)	26	24
Largest Digester Out of Service	19	18

Notes:
(1) Assumes a feed sludge thickness of 3.5%.
(2) Assumes existing Digester Nos. 1, 2, 3 and 4 and a new digester (the same size as Digester No. 4) are in operation.

6.2.6 Additional Capacity for FOG and Food Waste

Digesting FOG and food wastes, in addition to the biosolids produced at the WPCP, can increase digester gas production. Given the City beneficially uses digester gas to produce electricity, additional gas production would provide additional revenue to the City. Based on Carollo/HDR's experience, processing FOG and food waste is typically economically beneficial if additional digester capacity does not need to be built to accommodate the additional FOG or food waste load.

As discussed above, the SIP recommended that site space be provided to double the existing digester capacity in order to provide enough capacity to stabilize (digest) community organics that currently flow to the City's SMaRT Station, which is adjacent to the WPCP. Based on the analysis above, one additional digester the size of Digester No. 4 is required to treat the 2035 maximum month loads. Given that adding digester capacity to treat additional feed stocks is typically not cost effective, and that the plant site is constrained, it is recommended the City treat as much FOG and food waste as can be treated with the excess digester capacity (based on adding one digester as recommended).

If one digester the size of Digester No. 4 were implemented, the total digester capacity, with one unit out of service, would be 2.8 mgd. About 2.4 MG would be required to treat sludge, based on the 2035 MM sludge flow and loads presented herein and operating the digesters at a 15-day HRT, 3.5 percent feed sludge thickness, and a VSLR of 0.12 lbs VS/CF/day. The remaining 0.4 MG (about 15 percent of the firm digester capacity) would be available to treat FOG and food waste. As noted earlier, the actual excess digester capacity would have to be determined after the new primary and secondary treatment facilities are operational.

It is anticipated there will be enough excess digester capacity to treat the FOG waste that could potentially be collected within the City. The City developed projections for FOG as part of a digester rehabilitation and improvement study conducted in 2012 by Kennedy Jenks (Rehabilitation of Anaerobic Digester Nos. 1 and 2 and Improvements to No. 3). This study projected the City could collect as much as 3,000 gallons per day (mgd) of FOG from within the City. Based on the projected 2035 MM load, this FOG volume would account for about 2 percent of the total sludge volume sent to the digesters, which can easily be accommodated within the proposed digester facilities.

It is anticipated there will be some excess digester capacity to treat food waste. However, given the size of the WPCP and that the plant site is constrained, it is recommended the City only plan to treat emulsified (liquid) food wastes, such as syrups, as opposed to whole food wastes that require significant pre-processing. Accepting and treating whole food wastes is typically only cost effective at a larger scale treatment operation. In addition, the site is too constrained to accommodate the required pre-processing facilities. Emulsified food wastes are easy to digest and typically biodegradable. Adding emulsified food waste to the digester would also allow the digesters to be operated at a higher VSLR, however the achievable VSLR is difficult to predict until you start to digest this type of waste. It is recommended the City gain experience and become comfortable with digesting primary and WAS sludge first before accepting food waste.

6.3 Implementation Considerations (Phasing)

Based on the analysis presented herein, it appears additional digester capacity would be required to treat the 2025 MM Load, with the largest digester out of service. However, several factors impact when additional digester capacity would be required including: (1) the volume of the primary sludge that would be removed by the new PSTs; (2) the thickened sludge concentrations that would be achieved by the new PSTs; (3) the volume and characteristics of the WAS sludge that would be removed by the new secondary treatment facility; (4) the thickened sludge concentrations that would be achieved with the new RDT thickening facility; (5) whether the new secondary treatment facility would be implemented in phases (split-flow treatment) or in one phase; (6) whether influent flows and loads to the WPCP will increase as quickly as projected; and (7) the actual VSLR that the digesters can reliably operate at.

After start up of the new secondary treatment process (2023±), using the annual average loadings shown in Figures 5 and 6, it appears one digester could be taken out of service and the remaining digesters could be operated within a reasonable operating range with respect to HRT and VSLR. Given this, the City could wait about one year after the implementation of the new secondary treatment process to make the decision of when to implement a new digester. Because the new primary and secondary treatment process would significantly impact sludge production, it is recommended that at least six months of operational data be collected to update the sludge projections and assess the need for new digester capacity. Using this approach, the earliest a new digester could be on-line would be 2026± or as late as 2035± if the split treatment option is selected.

As discussed above, operating at a higher a VSLR and sludge feed thickness would delay the need for additional digester capacity. Therefore, immediately after the implementation of the Primary Treatment Facility project, the City should take the opportunity to optimize the digester operation (i.e., test higher VSLR loading rates) as well as to optimize the thickening operation in the new PSTs. Immediately after the implementation of the new secondary treatment process, the City should take the opportunity to optimize the digester operation for primary sludge and secondary sludge digestion as well as the to optimize operation of the new WAS thickening facilities.

6.4 Site Considerations

The following site considerations should be considered when determining the site layout and design of the digester facility:

- Provide site space for one additional digester that is the same size as Digester No. 4 (about 1.0 MG). Locate this new digester adjacent to the existing digesters.
- As part of the secondary treatment facility project, provide a WAS feed system, separate from the primary sludge feed system, that provides control and monitoring of WAS feed to digesters.
- Allocate WPCP site space for FOG and emulsified (liquid) food handling facilities.
- Allocate WPCP site space to provide for either pre-processing or post-processing sludge options to meet Class A requirements for at least a portion of the biosolids produced.

6.5 Findings/Recommendations

The findings and recommendations for anaerobic digestion include:

- Continue operating the existing mesophilic digestion process until there is a driver to produce Class A sludge. Digester Nos. 3 and 4 were recently rehabilitated and Digester Nos. 1 and 2 are currently being rehabilitated. Improvements to all four digesters include converting from a floating cover to a fixed cover; upgrading the digester heating and heat recovery systems; and converting the digester mixing system to a pumped mixing system.

- Expand the existing digester facility as needed to provide adequate process reliability and efficiency and to accommodate future sludge flows. It is anticipated one additional digester will be required between 2026± and 2035±, with the implementation impacted by future flows and loads as well as the potential split flow operation.

- Provide site space for one additional digester that is the same size as Digester No. 4 (about 1.0 MG).

- As included in the thickening recommendations, implement an automated sludge feed system to continuously and separately feed thickened PS and TWAS to each digester in operation.

- Allocate WPCP site space for fats, oils, and grease (FOG) and emulsified (liquid) food handling facilities.

- Allocate WPCP site space to implement either pre-processing or post-processing sludge options to meet Class A requirements for at least of portion of the biosolids produced.

- Continue to evaluate solids production and digestion values as part of the transition to the new PST facility and secondary treatment facility. These values include, but are not limited to: sludge production (lb/day), sludge feed thickness (percent solids), and VSS destruction (%).

7.0 DEWATERING

The dewatering process removes water from digested biosolids. The primary purpose of sludge dewatering is to reduce the volume and weight of the digested biosolids. This makes the biosolids easier and less expensive to transport and prepare for further processing or use/disposal.

This section summarizes the recommended preliminary design criteria for the dewatering process, an evaluation of technology alternatives, implementation and site considerations and recommendations for the new dewatering process.

7.1 Technologies Considered

7.1.1 Alternative Technologies

To select the best available technology for the proposed dewatering facility, a number of technologies were initially evaluated and discussed with City staff, including:

- Screw presses.
- Belt filter presses (BFPs).
- Rotary press.
- Centrifuges.

7.1.1.1 Screw Presses

Screw presses are comprised of an enlargening screw that is enclosed in a screen. Solids are conditioned with polymer and loaded into the top of the screw press. The screw conveys the solids to the discharge end of the press. As the solids are conveyed, they are pushed through a continually decreasing volume due to the enlargement of the screw. This increases the pressure along the length of the screw press, and forces the free water in the solids through the external screen. The separated water (pressate) is collected and discharged at the bottom of the screw press and returned to the liquid treatment process. The dewatered cake is discharged at the end of the screw press and conveyed for ultimate use and disposal. Figure 7 shows a schematic diagram of a screw press.

The screw press is gaining popularity in the municipal WWTPs due its mechanical simplicity, which allows it to be operated virtually unattended. Screw presses can achieve a cake solids concentration of 16 to 18 percent, which is relatively low compared to the other technologies. Screw presses also have a relatively low level of solids capture (less than 95 percent). Due to their enclosed configuration, screw presses, similar to centrifuges, contain odors better than belt filter presses. The expected polymer dosage required is similar to belt filter presses.

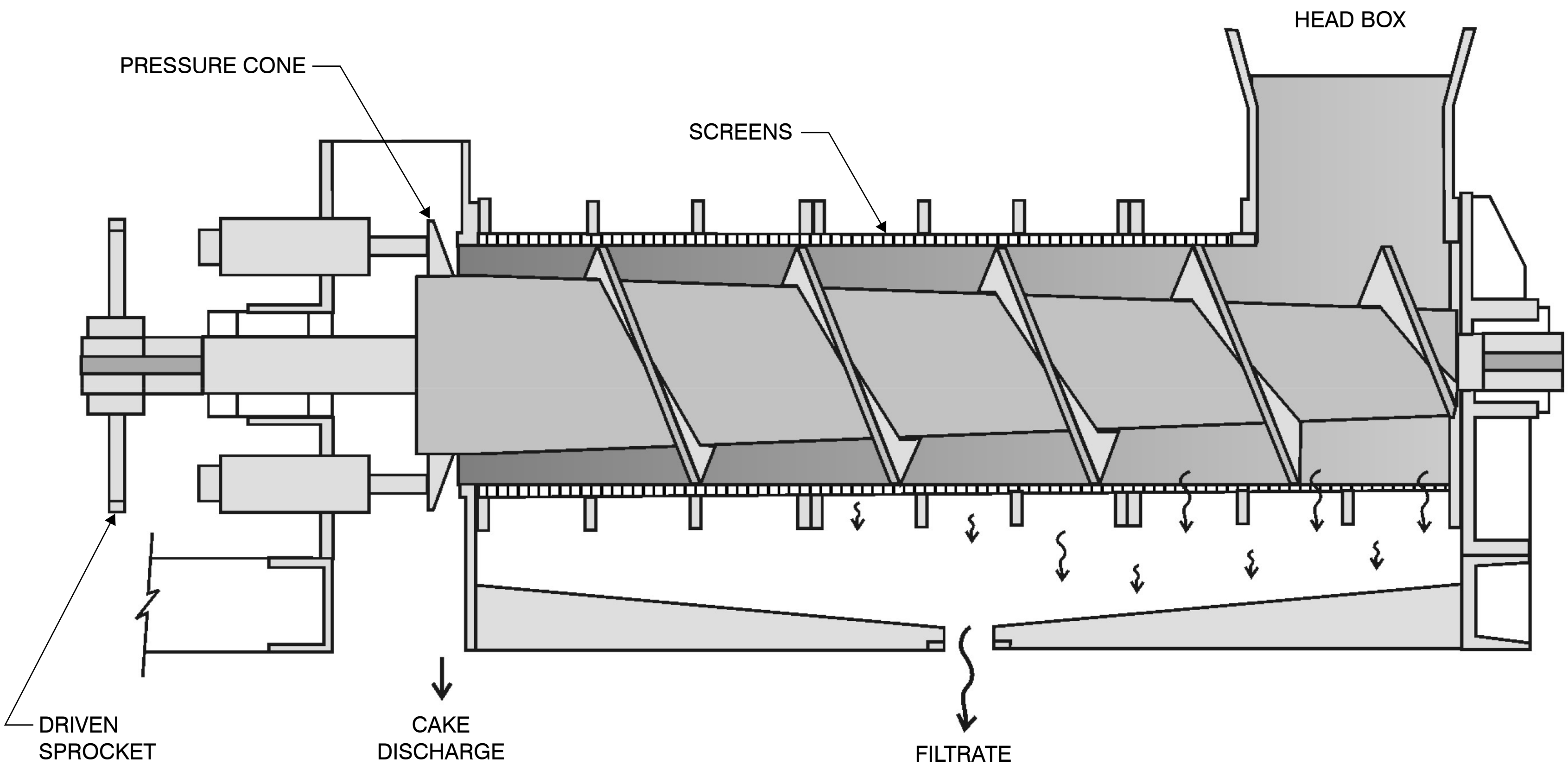

Figure 7
SCREW PRESS
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

7.1.1.2 Belt Filter Presses

BFPs are comprised of moving porous belts that continuously dewater solids. Polymer is first mixed with the solids to condition them for dewatering. The conditioned solids are then distributed on a porous belt and conveyed through a gravity drainage zone where water drains by gravity from the solids through the porous belts. The thickened solids are then pressed between two belts and rollers to remove additional water and produce dewatered cake. Filtrate is drained to the liquid treatment process and the dewatered cake is discharged and conveyed for ultimate use and disposal. Figure 8 shows a schematic diagram of a belt filter press.

BFPs require operator skill to observe and manage key variables to maintain dewatering efficiency, which include: incoming solids characteristics, polymer feed rate, solids conditioning with polymer, and belt speed and tensioning. As a result, unattended operation is not common. BFPs are typically more sensitive to the blend of influent primary and secondary sludge. BFPs can achieve a cake solids concentration of 15 to 19 percent, which is moderate compared to the other technologies. BFPs have a relatively high level of solids capture (95 to 98 percent). BFPs have an open design and as a result have a high odor potential. Although they can be provided with covers to contain odors, these covers significantly reduce the operator's ability to observe the sludge, which is critical to efficient dewatering operations.

7.1.1.3 Rotary Press

Rotary press dewatering, also recognized as rotary fan press dewatering, is comprised of low- and high- pressure zones, which rely on gravity, friction, and pressure differential to dewater solids. Before entering the low-pressure zone, solids are dosed with polymer and fed into a channel bound by screens on each side. The channel curves with the circumference of the unit, making a 180-degree turn from inlet to outlet. In this low-pressure zone, free water gravity drains through the filtering screen pores, which move in continuous but slow, concentric motion. Solids gradually enter the high-pressure zone as they travel towards the machine outlet where the pressure is controlled. Cake accumulates against the outlet gate, and the motion of the screens squeezes out additional water. The cake is continuously released through the pressure-controlled outlet and conveyed for ultimate use and disposal. Filtrate generated from both pressure zones is collected and returned to the liquid treatment process. Figure 9 presents a cut away of a typical rotary press module.

Rotary presses are gaining favorable attention from wastewater agencies as a viable dewatering technology. Although installation data is minimal, the dewatering performance of rotary presses is considered comparable to screw presses. Rotary presses can achieve a cake solids concentration of 16 to 18 percent, which is relatively low compared to the other technologies. Rotary presses also have a relatively low level of solids capture (less than 95 percent).

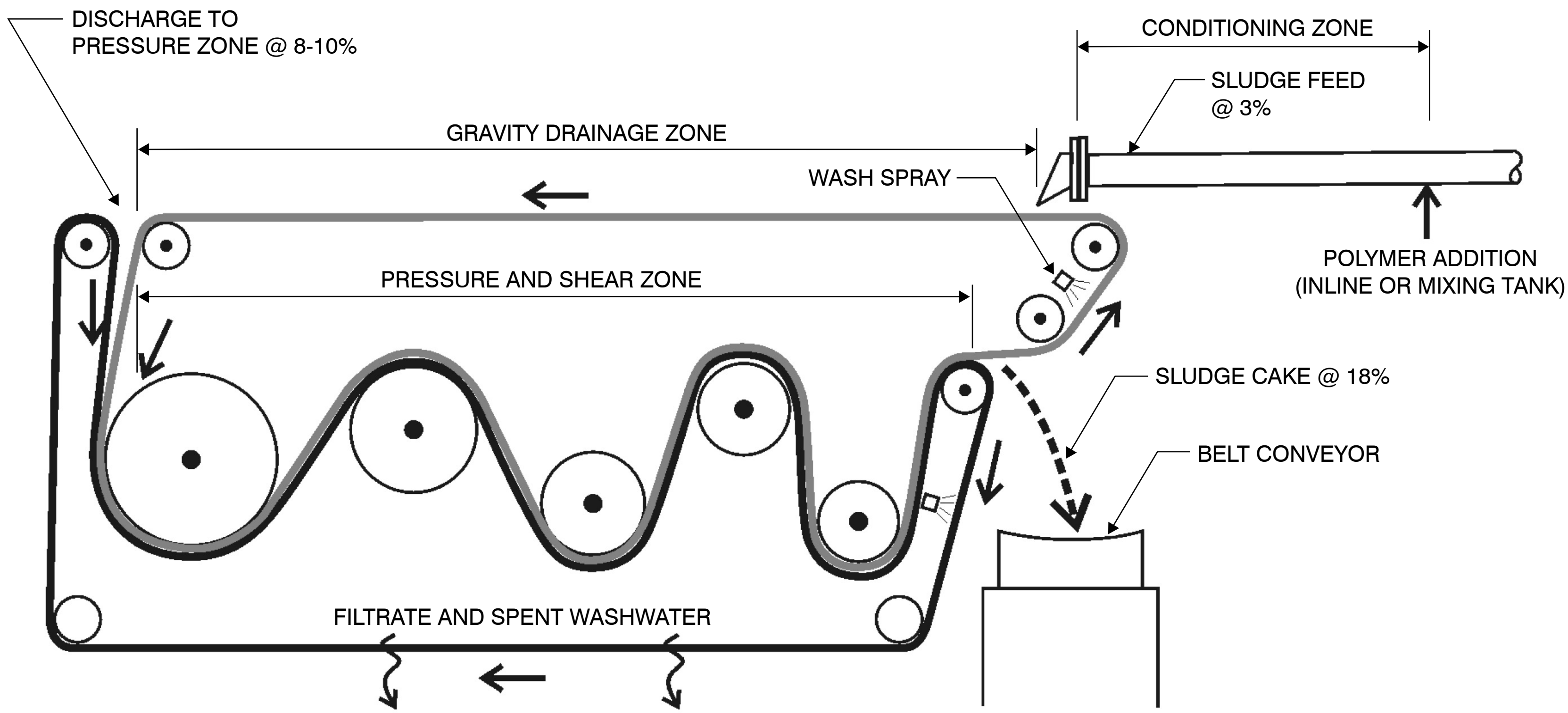

Figure 8
BELT FILTER PRESS
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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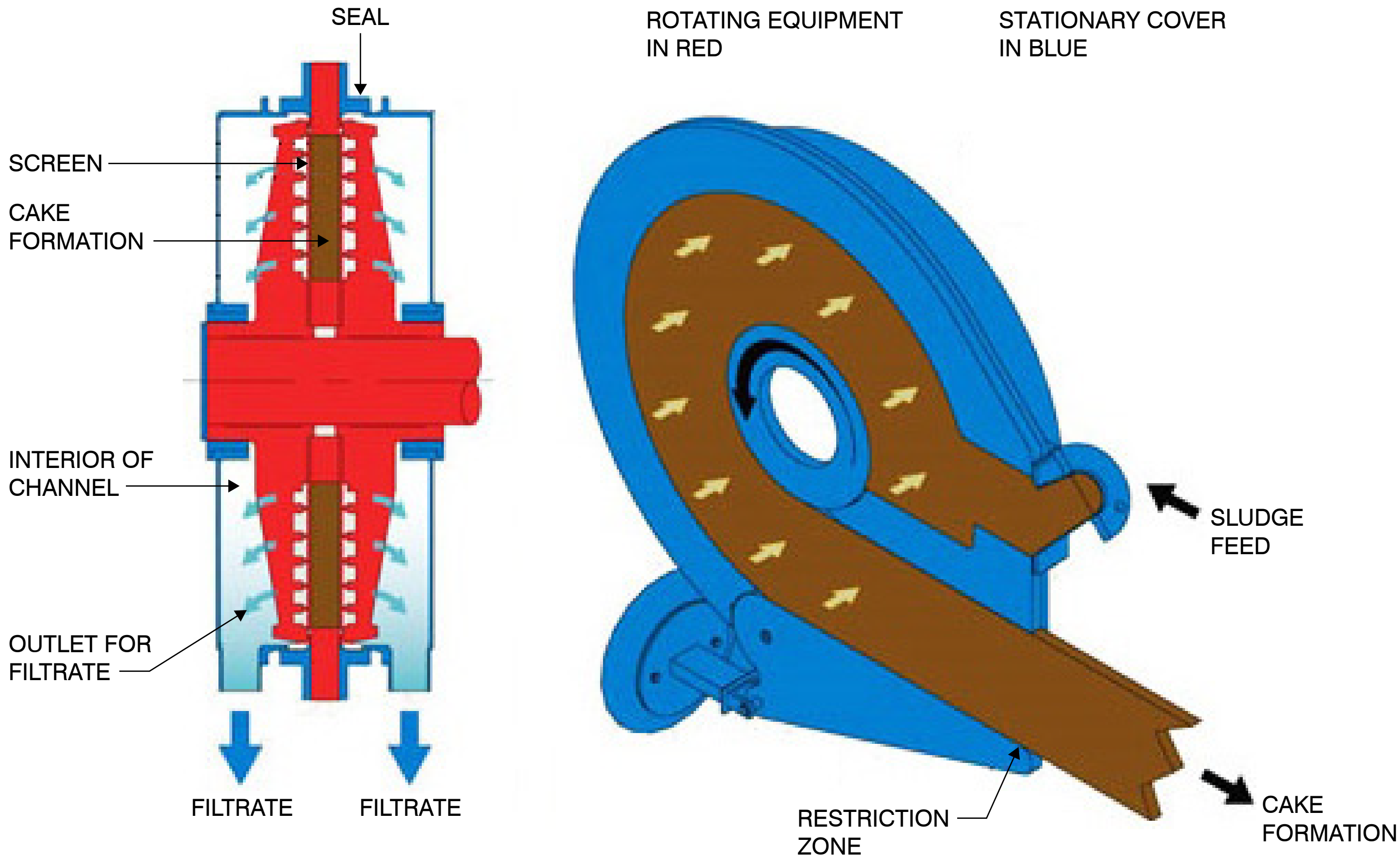

Figure 9
ROTARY PRESS
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

sun0114f8-9265.ai

7.1.1.4 Centrifuges

Similar to a thickening centrifuge, a dewatering centrifuge uses centrifugal force generated through high-speed spinning to separate sludge solids from the liquid stream and compress the solids into thickened sludge. Feed solids are pumped into a feed tube which extends into the rotating assembly of the centrifuge. The rotating assembly rotates at high speeds in the range of 2,500 to 2,900 rpm to create high centrifugal forces. The forces cause the solids and liquids to separate. The separated liquid (centrate) is collected and returned to the liquid treatment process. The separated solids are collected and are conveyed to the discharge end of the rotating assembly where they are collected for ultimate use and disposal. Figure 10 presents cut-away of a centrifuge.

Operator oversight can be minimized with typical operations and control features provided by manufacturers. Unattended operation is possible, though not common. Centrifuges can achieve the highest cakes solids of the technologies considered, about 20 – 24 percent solids. Centrifuges also have a relatively high level of solids capture (95 to 98 percent). Due to their enclosed configuration, centrifuges, similar to screw presses, contain odors better than belt filter presses. The expected polymer dosage required is higher for centrifuges than the other technologies considered.

7.1.2 Fatal Flaw Screening

Table 9 summarizes the key advantages and disadvantages of the dewatering technologies considered.

Based on an initial pre-screening conducted during the internal peer review held in September 2013, it was decided the BFP and rotary press would not be considered further for a number of reasons. Although BFPs can achieve relatively higher cake solids and solids capture, they were eliminated from consideration because they require a large footprint, have a higher odor potential, require greater operator attention and maintenance, and are more sensitive to primary and secondary blended sludge. Rotary presses were ultimately eliminated from consideration because there are fewer large-scale operating installations (>10 mgd) and they provide relatively low cake solids concentration and solids capture.

7.2 Alternative Analysis

To evaluate screw presses and centrifuges further, both a qualitative review and net present value analysis were performed. Hours of operation and preliminary design criteria were established to conduct the net present value.

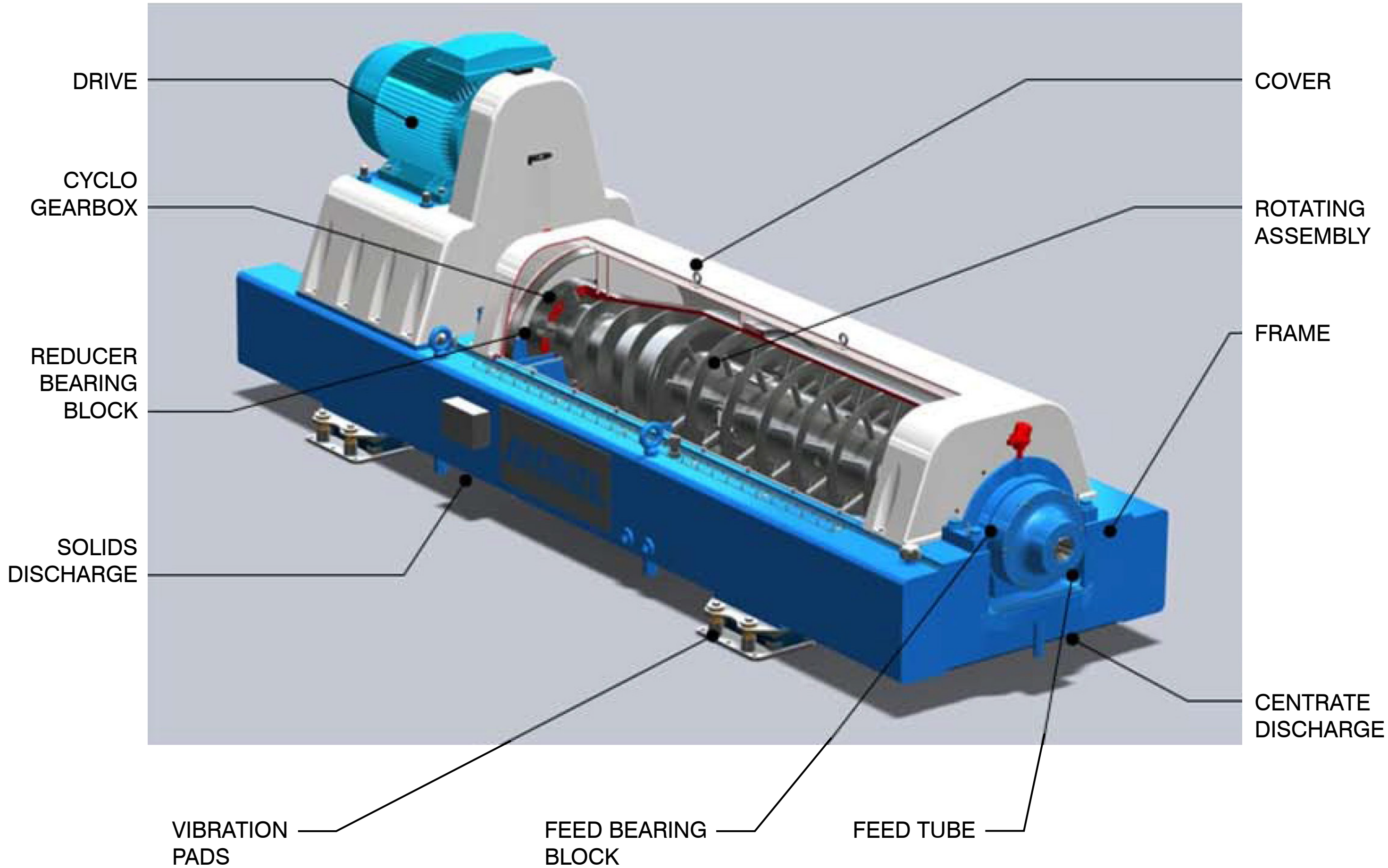

Figure 10
DEWATERING CENTRIFUGE
SOLIDS TREATMENT
MASTER PLAN AND PRIMARY TREATMENT DESIGN
CITY OF SUNNYVALE

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Table 9	Summary of Advantages and Disadvantages of Dewatering Technology Master Plan and Primary Treatment Design City of Sunnyvale	
Alternative	**Advantages**	**Disadvantages**
Screw Press	• Unattended operation feasible and common • Low O&M attention required • Few mechanical parts • Low power consumption • Less sensitivity to sludge feed • Low odor potential	• Lower cake solids concentration, solids capture, and throughput compared to BFPs and centrifuges • Larger footprint compared to rotary presses and centrifuges • Narrow operating range
Belt Filter Press	• Higher cake solids concentration and solids capture compared to screw presses and rotary presses	• Unattended operation not recommended • High O&M attention required • Greater sensitivity to primary and secondary blended sludge • High complexity • Larger footprint compared to rotary presses and centrifuges • High odor potential • Containment structure required for filtrate collection and drain
Rotary Press	• Low O&M attention required • Few mechanical parts • Low power consumption • Smaller footprint compared to screw presses and BFPs • Low odor potential	• Fewer installations compared to other technologies • Lower cake solids concentration, solids capture, and throughput compared to BFPs and centrifuges
Centrifuge	• Highest cake solids concentration, solids capture and throughput • High operating range • Smaller footprint compared to screw presses and BFPs • Less sensitivity to sludge feed • Low odor potential	• Unattended operation feasible but not common • High O&M attention required • High energy consumption • High polymer consumption • High noise generation and sound attenuation required

7.2.1 Hours of Operation

During the internal peer review in September 2013 and the workshop held in October 2013, the hours of operation of the dewatering process were discussed in order to develop and evaluate dewatering technology alternatives. The decisions were largely based on the n City's plans to implement unattended operation of the plant at night and over the weekend.

Staff expressed a preference for operating the dewatering process on a 5 days per week schedule. However, the hours of operation per day would be dependent on the dewatering technology selected. If centrifuges were selected, staff preferred operating the dewatering facility during day-shifts only because although unattended operation is possible, it is not common. For alternative comparison purposes, it was determined that centrifuges would be operated 7 hours per day, assuming 8-hour day shifts and start-up and shut-down of centrifuges takes about 1 hour. If screw presses were selected, staff preferred operating the dewatering facility 24 hours per day. Unattended operation of screw presses is more common, and running the screw presses 24 hours per day would reduce the number of units required and the overall cost of the facility.

7.2.2 Preliminary Design Criteria

It is recommended that the dewatering facility have enough hydraulic and solids capacity to treat the 2035 MM Load. The 2035 MM Load to the dewatering process is projected to be 27,000 pounds of digested biosolids per day with a total solids content of 2 percent.

7.2.3 Net Present Value Analysis

Table 10 summarizes the preliminary design criteria, sizing and results of the net present value analysis for a screw press system and centrifuge system. The net present value analysis was based on a 20-year lifecycle cost and includes capital costs and annual O&M costs including power, maintenance and labor costs. As shown in Table 10, a centrifuge system has a lower net present value than a screw press system due to its reduced annual operations and maintenance (O&M) cost. Although a centrifuge system would consume more power and polymer and require more operator attention and maintenance, it would achieve higher percent cake solids, which would reduce hauling and disposal costs. The reduction in hauling and disposal costs are estimated to be so great that centrifuges would have a lower annual O&M cost compared to screw presses.

7.2.4 Evaluation Summary

Table 11 summarizes how each dewatering technology meets the City's evaluation criteria for the Master Plan, which is described further in the SIP Validation TM.

Although a screw press system has a higher net present value, it is recommended over a centrifuge system based on WPCP staff preferences to operate a dewatering facility that does not require attended operation and requires minimal staff attention to operate and maintain. Based on the analysis summarized in Table 11, a screw press system is recommended over centrifuge system because: (1) it is a simpler dewatering system with fewer mechanical components; (2) unattended operation is feasible and common; (3) it requires less O&M attention; and (4) it consumes less power and polymer.

The recommendation to implement screw presses is consistent with the SIP recommendations. As stated in the SIP, screw presses were preferred over centrifuges due to their lower energy requirements.

Table 10 Net Present Value Analysis of Dewatering Alternatives Master Plan and Primary Treatment Design City of Sunnyvale		
Evaluation Criteria	**Screw Presses**	**Centrifuges**
Digested Sludge Feed, ppd	27,000	27,000
Sludge Feed Thickness, Percent Solids	2	2
Hours of Operation per Day/ Days of Operation per Week	24/5	7/5
Number of Units	3 duty + 1 standby	3 duty + 1 standby
Hydraulic Capacity, gpm	60	200
Solids Capacity, pph		
Estimated Polymer Dosage, lbs/dry ton	20 – 40	25 - 40
Dewatered Cake Thickness, Percent Solids	16 – 18	22 – 24
Capital Cost	$21.0 M ±	$19.2 M ±
Annual O&M Cost	$2.4 M ±	$2.2 M ±
Net Present Value	$47.5 M ±	$44.4 M ±

Notes:

(1) Cost estimates exclude common facilities (e.g., common yard piping, odor control facilities, etc.).
(2) Capital costs include escalation to midpoint of construction (June 2016).
(3) Power costs are based on an electricity cost of $0.20/kWh.
(4) Polymer costs are based on a polymer cost of $1.12/pound (active).
(5) Net present value is based on a 20-year life cycle.

It is recommended that the dewatering facility be designed to accommodate centrifuges due to future biosolids disposal considerations. The City may need to convert to a higher solids dewatering technology (i.e., centrifuges) if biosolids drying (e.g., drier or gasification system) is implemented to produce Class A biosolids. Such post-processing technologies typically require a biosolids feed thickness of 20 – 23 percent solids, which cannot be typically met by screw presses. The City could make this transition to centrifuges with little to no impact to the other treatment process. The decision to move to centrifuges could come at the end of the useful life of the screw presses or when it is decided to implement a technology requiring biosolids drying.

Table 11 Evaluation Summary of Dewatering Alternatives Master Plan and Primary Treatment Design City of Sunnyvale		
Evaluation Criteria	**Screw Presses**	**Centrifuges**
Reliability	0	0
Ease of O&M	+	-
Unattended Operation	+	-
System simplicity	+	-
Power and Polymer Usage	+	-
Flexibility	0	0
Site Efficiency	0	+
Net Present Value	-	+

Note:
(1) Legend: + Better; 0 Neutral; - Worse.

7.3 Implementation Considerations (Phasing)

7.3.1 Phasing

The dewatering facility should be sized to treat the 2035 MM Load. The entire dewatering facility required for 2035 MM Load would be constructed in one phase as part of the secondary treatment plant improvements. Equipment would be installed in two phases to provide dewatering capacity as needed. Three screw presses (two duty and one standby) would be installed as part of the initial phase of dewatering to accommodate the 2025 MM Load. One additional screw press would be installed as needed, as part of the second phase of dewatering to accommodate the 2035 MM Load.

7.3.2 Digester Sludge Storage and Dewatered Cake Storage

During the internal peer review in September and the workshop held in October 2013 it was determined digester sludge storage and dewatered cake storage would be required. Digested sludge storage would be required regardless of the dewatering technology selected. It would provide a necessary wide spot in the system, where digested sludge could be stored when the dewatering process is not in operation (e.g., on weekends during unattended operations or during planned and emergency shutdowns of the dewatering facility). Dewatered cake storage would provide storage of dewatered cake prior to it being hauled offsite to accommodate trucking delays/problems or problems at the beneficial use/disposal site.

It was determined the digester sludge storage tank should provide two days of digester sludge storage and the cake loading facility should provide one day of dewatered sludge storage during 2035 maximum month loads.

7.4 Site Considerations

The following site considerations should be considered when determining the site layout and design of the dewatering facility:

- The dewatering facility should be housed in a building and could be co-located with the thickening facility. In addition to the dewatering equipment, the building should house electrical, control and dewatering polymer facilities.
- Site space adjacent to the dewatering facility should be provided for: dewatering polymer storage; odor control facilities; digested sludge storage; and dewatered cake conveyance, storage and truck loading.
- The dewatering polymer system should be contained within the dewatering building. Polymer storage tanks should be contained outside the building under a canopy, to minimize the building footprint.
- The dewatering facility should include provisions for odor control, including containment and treatment for foul air within the screw presses.
- Adequate truck and crane/equipment access must be provided for operations and maintenance.
- A digested sludge storage tank should be provided upstream of the dewatering facility for digested sludge equalization. The tank should be sized to provide about two days of sludge storage at 2035 MM Load (estimated to be about 0.3 MG). It would have a similar design to the existing digesters.
- Dewatered cake conveyance (e.g., cake pumps or screw conveyor), cake storage, and truck loading facilities should be provided to convey, store and offload dewatered cake. The cake storage hopper should provide three days of sludge storage at 2035 MM Load.

7.5 Findings/Recommendations

The findings and recommendations for the dewatering process include:

- Dewater digested sludge with screw presses.
- Install three screw presses (two duty and one standby) as part of the initial phase of dewatering to accommodate the 2025 MM Load. Install one additional screw press as part of the second phase of dewatering to accommodate the 2035 MM load.
- Operate the dewatering facility 24 hours a day and 5 days a week.

- Co-locate the dewatering facility with the thickening facility inside a building. Cross-tie the WAS piping to the dewatering screw presses for digestion capacity backup.
- Provide site space adjacent to the dewatering facility for: dewatering polymer storage; solids handling odor control facilities; digested sludge storage; and dewatered cake conveyance, storage and truck loading.
- When the new dewatering facility is implemented, provide a digested sludge storage tank upstream of the dewatering process for digested sludge equalization. It is recommended the digested sludge storage tank provide two days of digested sludge storage during 2035 MM Load, which would result in a storage capacity of approximately 0.3 MG.
- Provide dewatered cake conveyance, cake storage, and truck loading facilities to convey, store and offload dewatered cake. It is recommended the cake storage hopper provide one day of cake storage during 2035 MM Load, which would result in a storage capacity of approximately 200 CY.
- The dewatering facilities should be designed with the flexibility to implement centrifuges should biosolids drying (i.e., drier or gasification) be required to produce Class A biosolids. The decision to move to centrifuges could come at the end of the useful life of the screw presses or when biosolids drying is required (~2030± - 2035±).

8.0 ODOR CONTROL

Solids treatment processes typically generate a high level of odors. As a result, most solids treatment facilities require some level of odor control to reduce odors onsite and prevent noticeable odors from spreading beyond the plant boundaries and affecting the area surrounding the WPCP.

This section summarizes odor regulations, odor testing that was conducted at the WPCP, an evaluation of odor control technologies, and recommendations for odor control at the preliminary treatment facilities.

8.1 Regulations

In the State of California, odors are regulated by CH&S code Section 41700 which states, “A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of people.” There is no regulation on how odor violations are determined.

The Bay Area Air Quality Management District (BAAQMD) has regulations to address certain odorous substances (e.g., hydrogen sulfide, sulfur dioxide). The limits are not applicable, however, unless a sufficient number of odor complaints are received.

The City has not received odor complaints for the current wastewater operations at the WPCP. Although the City has not received odor complaints, the City would like to develop a proactive approach to addressing odors as part of the long-term planning for the WPCP.

8.2 Onsite Odor Testing

In order to evaluate the odor generation potential at the WPCP, odor testing was performed at the WPCP on September 9th through 11th, 2013. The odor testing identified which odorous compounds are being emitted from each source and in what concentrations. This information was used to evaluate where odors control should be implemented as well as the use of potential odor technologies.

The methodology and results of the study are summarized in the Odor Testing Report TM. The key findings and recommendations of the study, as they relate to the preliminary treatment process include:

- There seemed to be little, if any, gas escaping from the anaerobic digesters. The solids in the dewatering beds were emitting almost no reduced sulfur compounds, which are most commonly seen in biosolids handling processes.
- The current solids handling processes at the plant are very good from an odor perspective.
- Based on experience at other facilities, the thickening and dewatering facilities would require some level of odor control depending on the processes, technologies, and locations that are ultimately selected.
- Provisions for odor containment and treatment should be provided for the thickening and dewatering facilities, as well as the digester sludge storage tank and the dewatered cake storage facilities.
- It is recommended one common odor control system be provided for the thickening and dewatering processes. This will reduce site space required for odor control and the overall cost of the odor control system.

8.3 Technologies Considered

The following odor control technologies are commonly used for odor control at wastewater treatment plants and were evaluated for treating odors generated by the thickening and dewatering processes:

- Activated sludge diffusion – diffusion of the odors into the aeration basins where they are oxidized
- Bioscrubber – a biological treatment process in which synthetic media is placed inside a vertical tower and odors are removed biologically

- Biofilter – a biological treatment process in which odors are removed biologically using organic or inorganic media, typically inside a custom built structure

All three technologies have been utilized successfully for many years and provide adequate odor control. However, since the secondary process will not be in operation until 2023 and due to some recent process control issues associated with activated sludge diffusion, activated sludge diffusion is not considered a viable alternative. Biofilters are a cost effective alternative, but typically require a significantly larger footprint than bioscrubbers. Based on a preliminary sizing analysis, use of biofilters is not practical due to the space limitations at the WPCP. Like biofilters, bioscrubbers require no chemical usage (if non-chlorinated plant effluent water is used in the system), utilize less site space and can be expanded to provide two-stage treatment of odors should more stringent odor control be necessary in the future. Given these advantages, package-type bioscrubber systems are recommended for scrubbing odors generated at the primary process. Further details will be provided during primary design.

8.4 Recommendations and Site Considerations

The findings and recommendations for odor control include:

- Provide a single, package-type bioscrubber system to treat odors collected at the thickening and dewatering equipment.

- Locate the odor control system near the thickening and dewatering building to simplify the odor piping design.

- Include the following provisions to adequately contain and exhaust odors generated at the solids treatment facilities and exhaust them to a bioscrubber system:
  - Cover and enclose the RDTs, screw presses, digester sludge storage tank, and cake loading facilities.
  - Completely seal the digester sludge storage tank and extract any biogas that may be produced in the tank with a gas piping system that is connected to the cogeneration system. The gas piping system would be similar to that of the existing digesters.
  - Install exhaust fans to extract enough air from the covered and enclosed RDTs, screw presses, and dewatered cake storage facilities to prevent fugitive emissions and convey the extracted air to the odor control system.
  - Install a ventilation system for areas that will be accessed by personnel to provide sufficient air changes required for worker safety.

Further details for the containment, ventilation, and treatment of odors, will be provided as part of the Basis of Design for the thickening and dewatering processes.

APPENDIX A – PROCESS ALTERNATIVES REVIEW WORKSHOP MINUTES AND SLIDES – OCTOBER 15TH, 2013

Engineers...Working Wonders With Water™

CONFERENCE MEMORANDUM

Project:	Master Plan and Primary Treatment Design	**Conf. Date:**	October 15, 2013
Client:	City of Sunnyvale	**Issue Date:**	October 31, 2013
Location:	West Conference Room		

Attendees:

City:
John Stufflebean
Kent Steffens
Craig Mobeck
Bhavani Yerrapotu
Bryan Berdeen
Dan Hammons
Melody Tovar
Manuel Pineda
Mansour Nasser
Alo Kauravlla

SCVWD:
Hossein Ashktorab
Luis Jaimes

Carollo/HDR/Subconsultants:
Jim Hagstrom
Jamel Demir
Jan Davel
Katy Rogers
Anne Conklin
Daniel Cheng
Scott Parker
Walid Karam
James Wickstrom

Boris Pastushenko
David Jenkins
Alex Ekster
J.B. Neethling

Dana Hunt
Hany Gerges
June Leng

Ray Goebel

Purpose: Process Alternatives Review Workshop (Workshop 2)

Distribution: Attendees **File:** 9265A.00

Discussion:
The following is our understanding of the subject matter covered in this conference. If this differs with your understanding, please notify us.

1. **FILTRATION**
   a. **Discussion**
      1) Regulatory Considerations and Implications
         a) The Basin Plan does not explicitly require filtration, but cites the use of filtration as a factor by which the South Bay treatment plants provide "equivalent protection" and hence qualify for an exception to the Basin Plan

prohibition on “shallow water” discharges. After some discussion, it was noted that the Master Plan will assume a filtration requirement for Bay discharge.

b) At the moment, Apple’s recycled water quality requirements are very stringent, sometimes more than potable water requirements. However, they seemed open to adjusting their requirements during negotiations with SCVWD. It was agreed to move forward with the assumption to provide Title 22 quality recycled water to Apple.

c) Some questions regarding TDS levels in WPCP influent. Overall water supply TDS is low. The City has discovered a pipe that is introducing Bay water to the collection system. The flow is estimated to be around 0.5 mgd and contributes 2,600 mg/l of TDS. The City is currently working to seal the leak, which should lower the influent TDS to the WPCP.

2) Long Term Alternatives

a) Analysis indicates that it is viable to continue use of the existing dual media filters.

b) A filter re-rating study should be perform to allow production of Title 22 quality water at higher filter loading rates (precedent set for this).

c) The analysis of alternatives indicates that supplementing with potable water is the lowest NPV option.

d) There was discussion on how peak flows would affect filter operation. It was noted that San Jose has loaded their filters at 9 gpm/sf during peak flows, and that the main considerations of peak flow loading is the exceedances of Title 22 filtration rate limits and a shortened filter run time.

e) It was noted that potable water blending will provide additional reliability to the recycled water system.

3) Short Term Alternatives

a) The existing chlorine contact basins can be modified to allow for a dedicated recycled water channel (eliminates batch operation).

b) With this modification, the existing filters, supplemented by potable water, could meet the near-term recycled water demands.

c) It was noted that the interim filtration requirements would need to be refined to consider the split treatment scenario.

d) While MBR and UF were only presented as short term solutions, there was interest in determining how much these facilities would impact the future secondary treatment costs.

4) SCVWD staff indicated that their Board has just approved funding for an indirect potable reuse (IPR) study. Therefore, the City should include IPR in the future MP process planning considerations. It was noted that the decision for the secondary processes will need to be made in the spring of 2014. Therefore, SCVWD will need to provide a clear direction for IPR prior to that. All agreed that the consideration of IPR will impact the short and long term recommendations for the filtration process.

5) **It is recommended that the existing filter facilities continue to be utilized for both Bay discharge and recycled water needs.**

b. **<u>Decisions</u>**

1) Final decision on filtration approach will be pending SCVWD's IPR evaluation.

c. **<u>Action Items</u>**

1) Carollo needs to determine impacts of peak flows on the final recommendation.

2) A separate meeting will be scheduled between the City and the master plan team to discuss possible impacts of IPR.

2. **DISINFECTION**.

a. **<u>Discussion</u>**

1) Regulatory Considerations and Implications

a) Current disinfection requirements include effluent limits for total coliform (for recycled water) and enterococcus (for Bay discharge). CECs, THMs and NDMA are future long-term considerations.

2) Alternatives

a) Based on near-term Bay discharge and recycled water demands, continue transition from gaseous chlorine to HOCl disinfection.

(1) Dedicate three chlorine contact tanks (CCTs) to Bay discharge and one CCT to recycled water.

(2) Identified need to add aqueous ammonia feed station to disinfect fully nitrified AS effluent. This avoids break-point chlorination to maintain the required chlorine residual (and also mitigates THM formation). THMs will continue to be monitored.

(3) UV could become an alternative when NDMA and THMs are regulated (long-term issue).

(4) Ozone would be an effective AOP for CECs (whether added to HOCl or UV or as a standalone single treatment technology).

b) There was a discussion on whether or not to add ammonia to free chlorine after the new secondary process comes online. Carollo/HDR recommended that the Master Plan analysis assume that ammonia addition is needed for chloramination. When TN limits become a reality, one option is to evaluate a dual disinfection process – chloramination followed by free chlorine. This is currently done in LA County.

c) The group noted that CEC's could be a direct concern if IPR is implemented.

d) Two ideas were proposed to mitigate THM formation:

(1) Perform breakpoint chlorination to mitigate NDMA. It was noted that free chlorine would not be effective for NDMA control.

(2) Add ozone prior to the filters, which allows the filters to more effectively remove precursors for THMs.

e) Carollo/HDR concluded that building an MBR for the near term recycled water demands alone is not a cost effective option.

f) **Carollo/HDR recommended that master planning site space be reviewed and potentially allocated at the WPCP for not only the HOCl and aqueous ammonia facilities, but for potential UV and ozone facilities.**

3) Layouts

a) Based on accommodating potential IPR needs, It was noted that an 8,000 sf RO facility will most likely not fit on the WPCP site if conventional AS is selected (MBRs provide space for an RO facility.

b. **<u>Decisions</u>**

1) Continue with the conversion to HOCl disinfection.

2) In future, once the NAS system is operational, add aqueous ammonia to chloraminate.

3) If NDMA limits precludes the continued addition of aqueous ammonia, monitor THM formation. If THMs become an issue, consider conversion to UV.

4) Once CECs become regulated, consider installation of an ozone system.

c. **<u>Action Items</u>**

1) Carollo to evaluate additional disinfection alternative to minimize THM production – chloramination followed by free chlorine disinfection.

HEADWORKS

a. **<u>Summary of Recommendations</u>**

1) Provide bar screens before pumping.

2) Build headworks structure for build-out flows. Analyze the phasing of mechanical equipment based on flow requirements.

3) Provide odor control for entire headworks facility.

4) Pump station

a) Rectangular wetwell.

b) Dual wetwell configuration

c) Dry-pit pumps

d) Vertical non-clog or submersible non-clog pumps

5) Screening

a) 3/8-inch bar spacing.

b) 3 duty screens, 1 standby screen, 1 bypass channel.

c) Multiple-rake or catenary screen (Duperon).

6) Screenings Conveyance

a) Shaftless screw conveyors.

7) Screenings Washing

a) Auger with Spray Washing.

8) Grit Removal

a) Eutek HeadCell.

b) Two duty plus one standby unit with hydraulic capacity for peak hourly flow, and treatment capacity for peak day flow.

9) Grit Washing

a) Huber Coanda.

b) One standby unit.

b. **Discussion**

1) Influent Pumping

a) There was concern regarding the long shafts inherent to dry pit non-clog pumps. The meeting participants agreed that dry pit submersible pumps should be further evaluated since they do not have associated long shafts.

b) It was noted that the cleaning requirements for the wetwells will be minimal since daily flows should provide sufficient scour.

c) The Master Plan team noted the difficulty of expanding headworks structures. After some discussion, there was general consensus that the headworks structure should be constructed for the buildout flows during the upcoming design, whereas the equipment will be phased in as flows increase.

2) Screening

a) Question raised about getting screenings out (30 foot depth) – sufficient experience noted for this approach. Should be focus of next rounds of field trips.

b) The selection of screen spacing was discussed (trade off of finer materials capture vs. effective organics separation. It was noted to the City that once the new headworks is constructed, the plant will be faced with a new reality – dealing with screenings at the front end of the plant (and not downstream in places like the digesters).

c) The SIP showed that the screenings washing/compacting facility will be housed in a canopy. However, the current assumption is that the screenings washing/compacting facilities will be housed in a masonry building for odor control. There was general agreement regarding this approach.

d) The screens will lift rags and solids above grade, eliminating the need for an angled screw conveyor between the screens and the washer/compactor.

3) Grit Removal

a) The grit study found that the grit at Sunnyvale is larger than typical grit found at similar plants. However, the grit settles slower than typical grit of similar size. The result is that the required grit facilities (Headcell or aerated grit basin) would need to be 60% larger than an equivalently sized facility at a typical treatment plant.

b) The NPV analysis recommends the selection of the HeadCell technology based on cost and footprint. However, it was noted that inspection and maintenance considerations will need to be further refined.

4) Grit Washing

   a) There was general agreement that even though Coanda is 25 – 30% more expensive than a cyclone, it produces higher quality grit and should be selected.

   b) The City expressed the desire to have a standby Coanda unit. Carollo/HDR recommend having a standby unit.

c. **Decisions**

1) Provide screens ahead of influent pumping.
2) Select 3/8" bar spacing.
3) Build headworks structure for buildout flows but phase in additional equipment as flows increase.
4) Provide odor control at the headworks.
5) Provide a pump station with a rectangular, dual, dry-pit configuration.
6) Provide shaftless screw conveyors for screenings conveyance.
7) Provide auger with spray washing for screenings washing/compaction.
8) Provide a building to house the screening and grit handling equipment.
9) Provide HeadCell for grit removal.
10) Provide Coanda for grit washing and dewatering.

d. **Action Items**

1) Schedule site visits to influent pump stations that are configured with a rectangular dry pit.
2) Resolve pump selection as part of pre-design
3) Carollo to identify potential sole-source equipment issues associated with the headworks implementation.

3. **THICKENING**

a. **Summary of Recommendations**

1) Based on analysis of alternatives, rotating drum thickeners (RDTs) are the recommended technology for thickening of WAS only
2) Could be used for co-thickening if that is desired
3) Could be co-located with dewatering facility

b. **Discussion**

1) Odor control will need to be provided as part of this facility.

c. **Decisions**

1) Provide RDTs to thicken WAS.

d. **Action Items**

1) City to visit some RDT facilities.

4. **DIGESTION**

a. **Summary of Recommendations**

1) Modify to allow all digester to operate as primary units.

2) Potential need identified for two additional digesters (needs to be evaluated after AS plant comes on-line). New digesters would be the same size as Digester No. 4.

3) Provide space for either pre-process or post-processing technologies.

b. **Discussion**

1) Regulatory Considerations and Implications.

a) No current or near-term drivers for Class A sludge

b) 503 regs drive HRT detention time (minimum of 15 days), but criteria used is typically more like 20 days. Analysis of future digester needs is based on 20 days.

2) It was noted that space should be left for pre-processing (sonication) and post-processing (drying) because industry trends indicate that these technologies will gain traction in the future.

3) Brought up the possibility of producing green waste pellets. It was noted that SRCSD tried a pelletizing operation, but discovered that it was costing $350/ton to operate, which is very expensive.

4) Co-thickening primary sludge and WAS can bring the sludge up between 5%-6% prior to digestion (determine sensitivity on future digester needs).

5) Regarding the possibility of receiving FOG, Carollo/HDR's experience is that projected FOG loadings are typically double the actual amounts generated. It was also noted that the City's SMaRT station will be rebuilt around 2021/2022, and any food/FOG waste can be considered as part of that renewal effort.

c. **Decisions**

1) Provide space for primary sludge screening.

2) Provide space for two additional digesters with the same capacity as Digester No. 4.

3) Provide space for possible FOG station to receive FOG and liquefied food waste.

d. **Action Items**

1) Carollo/HDR to show the impact of FOG and food waste in digester gas projections during the plant energy balance exercise.

2) Carollo/HDR to determine sensitivity of digester capacity as a function of sludge thickness.

5. **DEWATERING**

a. **Summary of Recommendations**

1) Centrifuges were lowest NPV alternative – but screw presses still under consideration.

b. **Discussion**

1) The group discussed the O&M requirements between screw presses and centrifuges. It was noted that centrifuges are more labor intensive but screw presses are more costly. Operations staff felt that screw presses could be operated with less attention.

2) Implementing centrifuges or screw presses are both viable options for sludge dewatering. The decision is largely dependent on O&M preferences.

c. **Decisions**

1) Delay the decision of sludge dewatering technology, until City staff visits screw press and centrifuge dewatering facilities and determines technology preferences.

d. **Action Items**

1) Carollo to organize site visits to screw press and centrifuge dewatering facilities with City staff.

6. **ODOR CONTROL**

a. Summary of Recommendations

1) Provide bioscrubbers for odor control

2) Near Term – Implement odor control at headworks and primary sedimentation tanks.

3) Long Term – Implement odor control at thickening/dewatering facilities.

b. Discussion

1) Odor testing at the plant site revealed that there are no major issues with RSC and VOCs.

2) Field testing work indicated odor issues associated with the existing headworks/primary sedimentation tanks.

c. Decision Log

1) Provide odor control at the headworks and primary sedimentation tanks as part of the Phase 1 project.

d. Action Items

1) None

Prepared By:

Daniel Cheng

DC:JD:dc

This workshop module will be a success if …

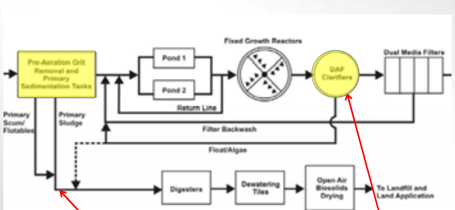
✓ Establish thickening process alternative

Agenda

- Existing process and SIP recommendations
- Alternatives analysis
- Recommendations
- Next steps

Existing Process and SIP Recommendations

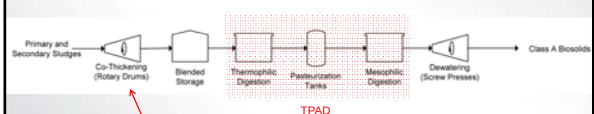
Process Flow Diagram – Existing Thickening



Primary sludge thickened in primary sedimentation basins and sent to digesters

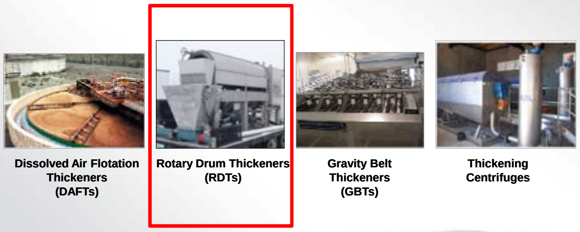
Dissolved Air Flotation Tanks (DAFTs)
- separate algae from oxidation pond effluent
- return algae to ponds or send to digesters

SIP Recommendations - Thickening



Co-thicken primary and secondary sludge in rotary drum thickeners (RDTs)

SIP recommended RDTs



Dissolved Air Flotation Thickeners (DAFTs) | Rotary Drum Thickeners (RDTs) | Gravity Belt Thickeners (GBTs) | Thickening Centrifuges

Alternatives Analysis

Key Decisions Impacting Thickening

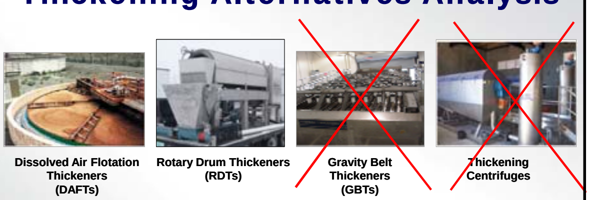
- As part of the primary sedimentation tank discussion, a decision was made to thicken primary sludge in the tanks
- This results in separate WAS thickening

Key Criteria for WAS Thickening

Dissolved Air Flotation Thickeners (DAFTs) | Rotary Drum Thickeners (RDTs) | Gravity Belt Thickeners (GBTs) | Thickening Centrifuges

- Flexibility to deal with variable WAS concentrations
- Low operator attention
- Ability to produce thickened sludge with minimal polymer usage and return stream impacts
- Minimize odor impacts

Thickening Alternatives Analysis



Dissolved Air Flotation Thickeners (DAFTs) | Rotary Drum Thickeners (RDTs) | Gravity Belt Thickeners (GBTs) | Thickening Centrifuges

Gravity Belt Thickeners (GBTs):

- 4-8 % solids
- Messy
- No cost savings over other alternatives
- Odor issues

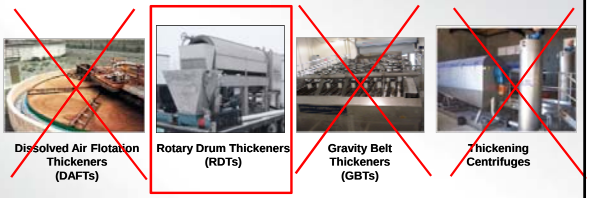
Thickening Centrifuges:

- 5-10 % solids
- No driver for higher solids
- High power cost
- More complex

Evaluated use of existing AFTs for WAS Thickening

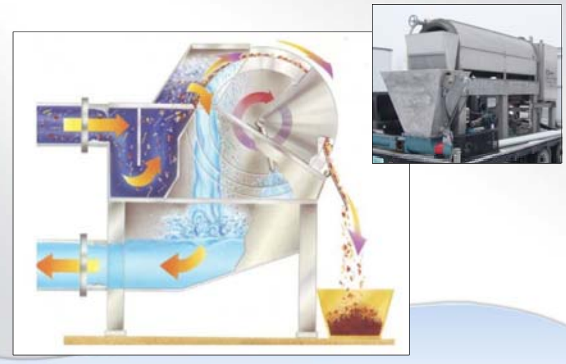
- 4 tanks
- 60 foot diameter tanks
- Based on evaluations at similar facilities, tanks are oversized and inefficient for use as WAS thickening
  - Air/solids ratios are very different for algae versus WAS
  - WAS AFTs require much higher polymer dose
  - Carollo recommends a maximum diameter of 40 feet for WAS AFT (confirmed by MOP 8)
  - AFTs would have to be covered for odor control
- Existing AFTs not recommended for use as WAS thickening

WAS Thickening Alternatives



- 4-7 % solids
- Easy to operate
- Clean
- Contains odors

Rotary Drum Thickener



Solids Projections

Parameter	Unit	2035 Maximum Month
Primary Sludge TSS	ppd	32,000
WAS TSS	ppd	18,000
Total solids load to digesters	ppd	49,000
Total VSS load to digesters	ppd	41,500
Total solids load to dewatering (1)	ppd	27,000

Notes:
(1) Assumes 95% capture of thickened solids
(2) Assumes PS thickening in primaries and separate WAS thickening process
(3) Assumes 54% volatile solids reduction in digesters

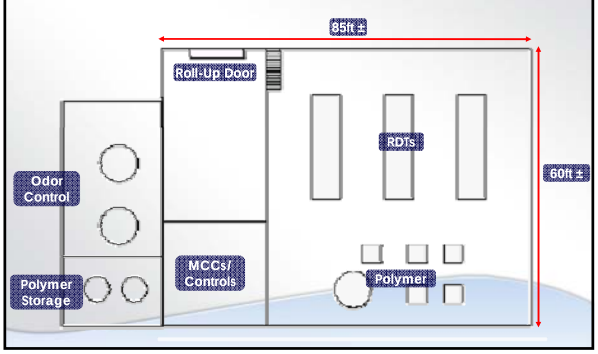
Design Criteria – RDT Thickening Facility

Parameter	WAS Thickening Only
Loading, ppd	18,000
WAS Concentration, %	1%
Thickened Sludge Concentration, %	5 – 6%
Solids Capture, %	95%
Polymer dose, active lb/ dry ton	10 - 20
Hydraulic Loading Capacity, gpm/unit	400
Solids Loading Capacity, lbs per hour/unit	2,000
Hours of Operation per Day, hrs	7
Days of Operation per Week, days	5
Number of units	2 duty, 1 standby

Thickening Site Considerations

- RDT design criteria
  - 2 duty units + 1 standby unit
  - 7 hours a day/ 5 days a week
  - Typically housed in a building
- Major design considerations for bldg layout:
  - Equipment and pumps inside building
  - Bridge crane and truck access required to remove equipment
  - Polymer support equipment inside building
  - Polymer storage tanks outside, under canopy
  - Odor control/ventilation required for building
  - Potentially co-locate with dewatering process
- Sludge storage tank
  - Allows blending of WAS and PS to digesters
  - Primary sludge storage upstream of digesters
  - Maximum of 4-6 hour HRT

Plan – Thickening Building



Recommendations

Thickening recommendations

- Select an RDT for WAS thickening
  - Currently have a preferred vendor based on quality of equipment
  - May require special procurement approach (TBD)
- RDTs will be housed in a building
- RDT site location flexible

Next Steps

Next steps

- Tour installations
  - Eastern Municipal Water District/Moreno Valley/ Temecula Valley, CA
  - Fallbrook, CA
  - Salida, CA

This workshop module will be a success if …

✓ Establish thickening process alternative

End

This workshop module will be a success if …

- ✓ Understand impact of biosolids regulations
- ✓ Establish future digestion needs and related facilities

Agenda

- Regulatory considerations and implications
- Existing process and SIP recommendations
- Key planning considerations
- Solids projections and digester capacity
- Recommendations
- Next Steps

Regulatory Considerations and Implications

Regulatory Considerations for Biosolids

- Digestion covered by 503 Biosolids Regulations
  - Pathogen/Vector Reduction
  - Class B Anaerobic Digestion
    - 15 days HRT @ 95 degrees F
    - Minimum 38% VSS reduction
- No apparent further federal or state limitations being considered (except for incineration)
- Land application increasingly restricted by counties, but still available near term for Class B
- Fewer landfills accepting biosolids (ADC may not be considered beneficial reuse), but still available as potential backup option

Viable Beneficial Use / Disposal Alternatives

- Landfill for ADC or disposal – Numerous, but fewer in the future
- Local land application: (note that all accept Class B)
  - Solano County
  - Merced County
  - Sacramento County
  - Sonoma County
- ~~Other plants with digestion capacity (same use/disposal)~~
  - San José
  - EBMUD
- Exceptional Quality (EQ) products (Class A plus Table 3/VAR)
  - Synagro - Merced County composting
  - New Dryer
- Energy - Future
  - BAB2E

Impact of Biosolids Regulations

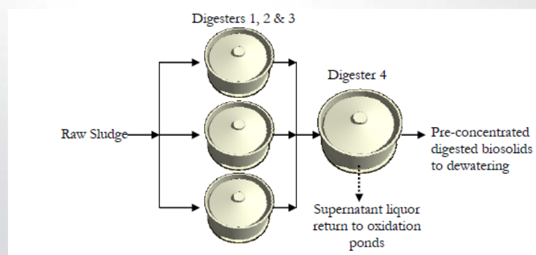
- Develop a diversified beneficial use/disposal plan
- Near term – no drivers for Class A digested sludge
  - Land application/ADC as long as possible
  - Monitor developing technologies
- Long term – other alternatives may become available
  - Heat Drying/composting
  - BAB2E

Impact of Biosolids Regulations

- Process impacts
  - Screening of primary sludge
  - Optimize thickening process to maximize digester capacity
  - Provide flexibility to produce Class A digested sludge in future (site space for pre- or post- processing)
  - Selection of dewatering technology that facilitates flexibility in disposal options

Existing Process and SIP Recommendations

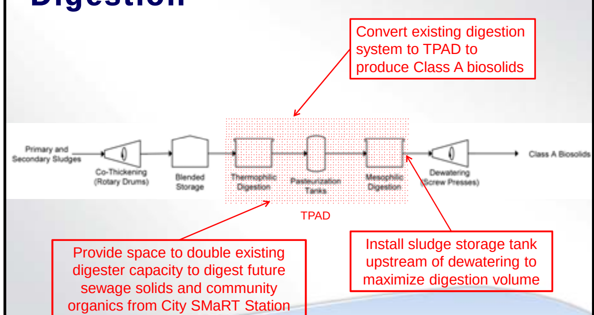
Process Flow Diagram – Existing Digestion (Class B)



Existing Digestion Facilities

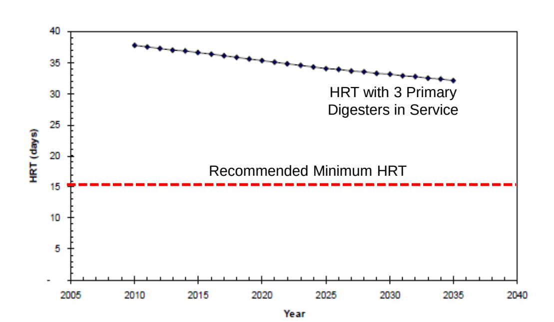
Description	Value
Number of Units	4
Tank Diameter Digesters 1 – 3 Digester 4	 55 feet 70 feet
Tank Side Water Depth	33 feet
Volume Digesters 1 – 3 Digester 4 TOTAL	 0.6 MG each 1.0 MG 2.8 MG

SIP Recommendations - Digestion

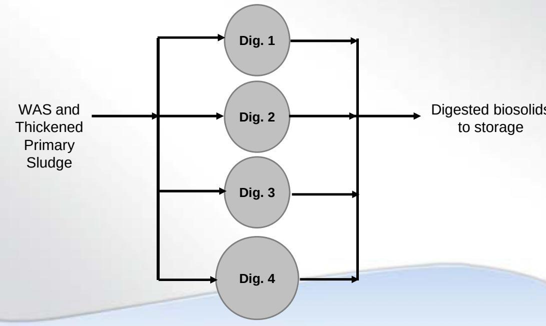


Digestion Capacity – PS Only (SIP)

SIP unclear regarding capacity to handle PS and WAS (four digesters added plus TPAD)



Process Flow Diagram – Future (Class B)



Key Planning Considerations

Key Decisions Impacting Digestion

- Separate thickening of primary and secondary sludge
  - Impacts percent feed solids to digestion/dewatering
  - Requires small holding tank for blending of primary sludge with WAS
- Use Digestion No. 4 as a primary digester, not secondary digester

Key Criteria for Digestion

- Meet 503 regulations (i.e., 15 day HRT, etc.)
- Maximize digester gas production
- Provisions to take digesters offline for cleaning
- Provide flexibility to produce a Class A sludge
  - TPAD
  - Pre-processing (practical application at a plant the size of WPCP)
  - Post-processing
- Deal with alternative feed stocks
  - FOG
  - Food waste

Solids Projections and Digester Capacity

Solids Projections

Parameter	Unit	2025 Maximum Month	2035 Maximum Month
Primary Sludge TSS	ppd	29,000	32,000
WAS TSS	ppd	17,750	18,000
Total solids load to digesters	ppd	46,000	49,000
Total VSS load to digesters	ppd	39,000	41,500
Total solids load to dewatering [1]	ppd	25,000	27,000

Notes:
(1) Assumes 95% capture of thickened solids
(2) Assumes PS thickening in primaries and separate WAS thickening process
(3) Assumes 54% volatile solids reduction in digesters

Digestion Design Criteria

- Assumed feed solids (impact of dealing with expected vs. minimum, 3.5 – 4% TS)
- HRT assumptions (minimum of 15 days at maximum two week peak flow)
- VSS loading rate of 0.12 – 0.15 lbs per cubic foot
- Reliability/redundancy criteria (largest unit out for routine maintenance/cleaning)

Digester Volume

Digester	Total Volume MG	Volume Filled with Grit, %	Total Active Volume MG
No. 1 - 3	0.6	10%	0.55
No. 4	1.0	10%	0.9
Total with All Units in Service	2.8	10%	**2.5**
Total with Largest Unit out of Service	1.8	10%	**1.7**

Digester Capacity – 15 day HRT

Year	Digester Volume Required MG	Capacity Excess/Deficit (all units in service)	Capacity Excess/Deficit (largest unit out of service)
2025	2.3	0.2	-0.7
2035	2.5	0	-0.9

Notes:
(1) Assumes 95% capture of thickened solids
(2) Assumes 3% PS thickening in primaries and 5% WAS thickening
(3) Assumes 54% volatile solids reduction in digesters

Digester Capacity – 20 day HRT

Year	Digester Volume Required MG	Capacity Excess/Deficit (all units in service)	Capacity Excess/Deficit (largest unit out of service)
2025	3.1	-0.6	-1.5
2035	3.4	-0.8	-1.7

Notes:
(1) Assumes 95% capture of thickened solids
(2) Assumes 3% PS thickening in primaries and 5% WAS thickening
(3) Assumes 54% volatile solids reduction in digesters

Digester Capacity – Summary

	Year	Digester Volume Required MG	Capacity Excess/Deficit (all units in service)	Capacity Excess/Deficit (largest unit out of service)
15-day HRT	2025	2.3	0.2	-0.7
	2035	2.5	0	-0.9
20-day HRT	2025	3.1	-0.6	-1.5
	2035	3.4	-0.8	-1.7

Notes:
(1) Assumes 95% capture of thickened solids
(2) Assumes 3% PS thickening in primaries and 5% WAS thickening
(3) Assumes 54% volatile solids reduction in digesters

Potential FOG Volume

Parameter	Value
FOG Production	13.37 lbs per capita per year
Population	140,000
Grease Concentration	6%
FOG Fed to Digesters	10,000 gpd
FOG Fraction of Sludge to Digesters	6% ±

Recommendations

Digestion Recommendations

- Provide site space for 2 additional digesters equivalent to digester No. 4 (based on 20 day HRT and one digester out of service)
- Provide site space for potential pre-processing technologies
- Provide site space for FOG and food handling facilities (one tank for FOG and one tank for emulsified food waste)
- Continue to evaluate solids production values as part of transition to secondary treatment

Full Site Layout – Conventional Activated Sludge with West Rectangular Clarifiers

Next Steps

Next steps

- Need to develop FOG ordinance to establish City's right-of-first refusal for all FOG generated within the City limits (preserves option for future FOG)
- Need to develop a diversified beneficial use/disposal plan

This workshop module will be a success if …

- ✓ Understand impact of biosolids regulations
- ✓ Establish future digestion needs and related facilities

End

This workshop module will be a success if …

✓ Establish dewatering process alternative

Agenda

- Regulatory considerations and implications
- Existing process and SIP recommendations
- Alternatives analysis
- Recommendations
- Next steps

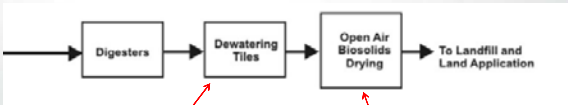
Regulatory Considerations and Implications

Impact of Biosolids Regulations

- Process impacts
  - Screening of primary sludge
  - Optimize thickening process to maximize digester capacity
  - Provide flexibility to produce Class A digested sludge in future (site space for pre- or post- processing)
  - Selection of dewatering technology that facilitates flexibility in disposal options

Existing Process and SIP Recommendations

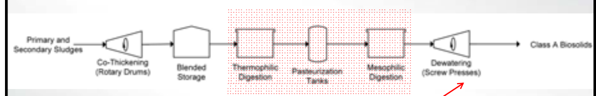
Process Flow Diagram – Existing Dewatering



Dewatering Tiles
- Digested sludge mixed with polymer and hosed onto tiles
- Filtrate pumped to oxidation ditches
- 70% +/- dry solids*

Biosolids Drying
- Dewatered solids hauled to paved final drying area for solar drying

SIP Recommendations - Thickening



- Initially recommended dewatering with screw presses
- SIP update recommended centrifuges as potential alternative

SIP Recommendations – Thickening Technology

Belt Filter Press

Screw Press

Centrifuge

- Also viable
- Day-shift only operation
- Drier cake (good if hauling/disposal costs go up)

Alternatives Analysis

Key Decisions Impacting Dewatering

- Digester No. 4 not available for decanting or sludge storage upstream of dewatering due to capacity limitations

Key Criteria for Dewatering

- Provide upstream storage and blending of digested solids
- Minimum cake solids required for disposal
- Minimizing odor containment/treatment costs
- Provisions for cake storage for disposal flexibility
- Operational hours for equipment

Dewatering Alternatives

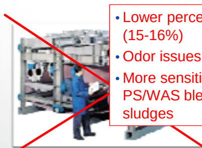
Belt Filter Press

Screw Press

Centrifuge

Rotary Press

Dewatering Alternatives

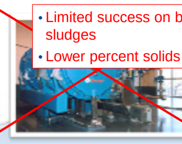


- Lower percent solids (15-16%)
- Odor issues
- More sensitive to PS/WAS blended sludges

Belt Filter Press

Screw Press

Centrifuge



- Limited success on blended sludges
- Lower percent solids (15-16%)

Rotary Press

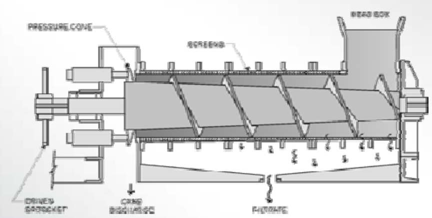
Screw Press

\+ Unattended operation
\+ Lower maintenance
\+ Lower power consumption
\+ Fewer mechanical parts
\+ Contains odors

– Lower cake solids concentration
– Lower solids capture
– Lower hydraulic throughput

– Preferred Manufacturers: Huber, FKC

Screw Press



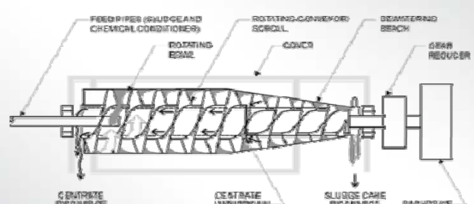
Centrifuge

\+ Higher cake solids concentration
\+ Contains odors
\+ Higher hydraulic throughput and turndown

– Unattended operation possible, but not common
– Higher polymer usage
– Higher power consumption
– High noise levels

– Potential Vendors: Andritz, Westfalia, Alfalaval

Centrifuge



Solids Projections

Parameter	Unit	2025 Maximum Month	2035 Maximum Month
Primary Sludge TSS	ppd	29,000	32,000
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Total solids load to digesters	ppd	46,000	49,000
Total VSS load to digesters	ppd	39,000	41,500
Total solids load to dewatering (1)	ppd	25,000	27,000

Notes:
(1) Assumes 95% capture of thickened solids
(2) Assumes PS thickening in primaries and separate WAS thickening process
(3) Assumes 54% volatile solids reduction in digesters

Comparison of Alternatives

Planning Criteria	Centrifuge	Screw Press
Digested Solids Feed, ppd	27,000	
Dewatered Cake, % solids	22	16
Average Range, % Solids	22 - 24	16 - 18
Hours of Operation per Day/ Days of Operation per Week	7/5	24/5
Number of Units for 24/7 Operation	3 duty, 1 standby	3 duty, 1 standby
Hydraulic Capacity, gpm	200	60
Installed Horsepower per Unit	200/30	7.5
Estimated Polymer Dosage, lbs/dry ton	25 - 40	20 - 40

Evaluation of Alternatives

	Centrifuges	Screw Presses
Reliability	0	0
Ease of O&M	0	+
Maximize Resources	n/a	n/a
Power Usage	-	+
Flexibility	+	-
Ease of Implementation/ Compliance	0	0
Site Efficiency	+	0
Capital	$19.2M ±	$21.0M ±
Annual O&M	$1.8M ±	$2.0M ±
Net Present Value	$38.1M ±	$42.2M ±

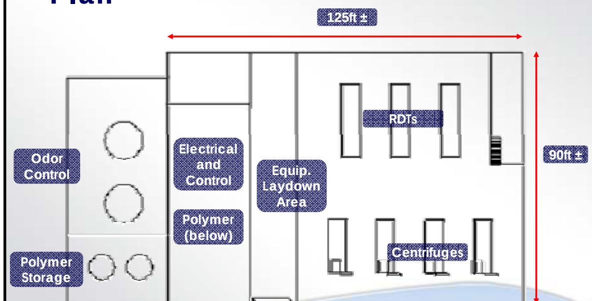
+ Better | 0 Neutral | - Worse

Recommendations

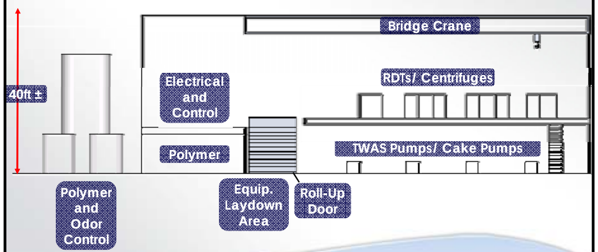
Dewatering Recommendations

- Dewatering
  - Recommend use of centrifuges because of flexibility and site efficiency considerations
- Cake Conveyance
  - Cake pumps
- Cake Storage
  - Plan for four days worth of storage
- Major design considerations for bldg layout:
  - Equipment and pumps inside building
  - Bridge crane and truck access required to remove equipment
  - Polymer support equipment inside building
  - Polymer storage tanks outside, under canopy
  - Odor control/ventilation required for building
  - Washwater
  - Potentially co-locate with thickening process

Thickening / Dewatering Building - Plan



Thickening/Dewatering Building - Section



Thickening/ Dewatering Implementation Considerations

- RDTs must be implemented with secondary treatment improvements for thickening of WAS (~2022)
- Current dewatering operation will be impacted by headworks and primary sedimentation tank expansion project
  - Potential exists for retaining some or all of the existing dewatering tiles operation
  - In lieu of that, City will have to look at other options (i.e., contract dewatering)
- New dewatering facility could be implemented at the same time as the thickening facility

Next Steps

Next steps

- Tour centrifuge installations
  - Denver Metro
  - Fort Collins
  - San Mateo
  - Roseville
- Tour screw press installations
  - Petaluma
- Evaluate contract dewatering/disposal options
- As part of overall site layout considerations, review available space for potential post-processing alternatives

This workshop module will be a success if …

✓ Establish dewatering process alternative

End

APPENDIX B – PRE AND POST PROCESSING ALTERNATIVES TO PRODUCE CLASS A SLUDGE

City of Sunnyvale Water Pollution Control Plant

Pre and Post Digestion Sludge-Biosolids Processing Analysis

Introduction

The City of Sunnyvale WPCP has primary and secondary treatment processes which the master plan proposes will provide primary and thickened sludges to anaerobic digesters for solids destruction, pathogen reduction, vector attraction reduction, and biomethane production. Since anaerobic digestion is the most energy efficient wastewater treatment process – producing more energy than it uses – and since it allows for even more biomethane production through the potential of FOG and food waste digestion, this is the logical choice as the city moves towards the goal of energy self-sufficiency.

There has been a concerted effort to develop pre and post anaerobic digestion processes to:

1. Improve the digestibility of the sludges – especially waste activated sludge so that more biogas is produced,
2. Reduce the volume and weight of the biosolids hauled from the site,
3. Reduce the cost of anaerobic digestion and post processes,
4. Provide a higher pathogen kill – produce Class A Biosolids to provide more beneficial uses,
5. Produce a usable product – such as pellets or compost from the digested sludge/biosolids.

This section of the master plan addresses the currently available options for onsite pre and post digestion processing. It is recommended that when decisions on beneficial uses, digestion capacity, thickening, and dewatering need to be made the available options and their benefits be reviewed.

Pre-Digestion Processes

Available pre-digestion options include:

1. Sonication - Sonolyzer – using ultrasonic wave energy to breakdown cells,

2. Thermo-hydrolysis – Cambi and Exelys – using heat and pressure release to breakdown cells and reduce the viscosity of the sludges,
3. Electrical pulsing – Open Cell – using electrical energy to breakdown the cells,
4. Pasteurization - ECO-THERM – using high temperatures to breakdown the cells,
5. Chemical and Pressure treatment – Micronair or MicroSludge – using caustic chemicals and pressure release to breakdown cells.

In plant studies to date have found that Pasteurization, Chemical and Pressure Treatment, and sonication does breakdown the cells and makes some limited improvements to the digestibility though they do not appear in most cases to be worth the added cost or energy use. There is some data indicating that the Electrical pulse – Open-Cell process may have more promise, but full scale data is very limited and ongoing studies such as the one at Orange County Sanitation District should help clarify the benefits and costs of this process.

Thermo Hydrolysis – The Thermo-hydrolysis process seems to have the most promise and most potential benefit. This is because the process not only breaks down the sludges – especially activated sludge, it also can achieve Class A pathogen destruction and reduces by up to half the required digester volume. This is because the process allows thickening the sludges to 15 to 16 percent solids because it decreases the viscosity of the sludges, so that even with the higher solids concentrations the digester can be adequately mixed. One other benefit is that data from the other plants using the Cambi process indicates that dewatered cake biosolids concentrations of 28 to 32 percent solids can be achieved with either a belt press or centrifuge.

Conversely, the Cambi process is a complex high temperature and pressure process requiring equipment to pre-thicken to 15 to 16 percent solids. This process requires high pressure steam for the treatment process and usually uses centrifuges to achieve the pre-digestion dewatering solids concentrations. It may be possible to achieve adequate pre-digestion thickening through use of screw presses. While this process does achieve Class A pathogen reduction and reduce the amount of biosolids produced, the biosolids do still look and smell like sludge.

Suggested implementation through the master planning process –

1. Because Thermo-hydrolysis will reduce the needed digester volume, it could be sited in place of a future digester without taking added plant area.
2. Thermo-hydrolysis will require a pre-thickening step which has typically been accomplished by centrifuges, but potentially by screw presses. Because of this and the potential need to reduce the flow and/or load to the digesters during cleaning, it is recommended that the piping be arranged to allow primary and/or waste activated sludge to be sent to the screw presses. This may require some pre-thought as to how the 15 to 16 percent solid sludges could be transported to the Cambi process.

Post –Digestion Processes

Post digestion processes fall into several different general categories: Thermal drying, thermal oxidation, solar drying, composting and other developing processes. The WPCP is eliminating the current solar drying process as a result of in adequate area and the need to utilize the available space for other processes and reduce odors. Similarly, composting would require more area than is available on the site. Co-composting with other green or food wastes at the landfill site should be further explored. Thermal drying, thermal oxidation and other developing options are further explored below.

Thermal Drying – Thermal drying uses excess heat from cogeneration, heat generated from biogas or natural gas or heat from an offsite source to dry the biosolids. This can be done through a direct drier or an indirect drier. Configuration options include rotary drum, belt, multiple hearth, and fluidized bed. Plus, there are batch and continuous feed systems. For a facility the size of the Sunnyvale a continuous feed, indirect heat, belt drier, rotary auger, or rotary drum dryer would be recommended.

The rotary auger dryer such as the Therma-Flite or Komline-Sanderson Dryers can do an excellent job of drying the biosolids to a range of 70 up to 95 percent solids. They can also use waste heat though it must be at least in the 200 degree F range to be viable for syngas as a fuel source.

The belt dryers such as the Andritz can use a lower temperature heat source for the drying air, though it takes increasingly more surface area as the drying air gets cooler.

There are a couple of recently developed drying processes that should be carefully followed. One newly developed drying process was piloted and is not being developed at commercial size at the South Bayside System Authority Treatment Plant. This process utilizes bacterial action to generate enough heat to dry the biosolids to 60 to 70 percent solids in about 10 days. A second developing dryer is the Gryphon dryer which uses a vacuum and less heat to dry the biosolids with only about 60 percent of the energy required for normal drying.

Dryers have the advantage of significantly reducing the volume and weight of the sludge – to the range of 10 to 25 percent of the incoming biosolids cakes. Dryers also have the advantage of producing a product of pellets which make a usable soil amendment of fertilizer for golf courses or other local grassy areas. The pellets can also be used as a fuel for biofueled power plants or cement kilns.

The rotary auger driers will fit in the proposed site and with higher biogas production provided by FOG and/or food waste digestion should be able to dry the produced biosolids using little supplemental fuel. The belt dryer could be designed to not require supplemental fuel, but this size dryer might not fit in the limited space available.

Thermal Oxidation – These process generally includes:

1. Incineration is the process of adding enough air or oxygen to allow complete oxidation of all the combustible materials in the sludges in one chamber,
2. Gasification provides just enough oxygen to allow enough heat so that the combustible gases or syngas is driven off. The syngas is usually used as an energy source in a succeeding process to provide heat to a dryer, fuel to an internal combustion engine, or as a carbon source for hydrogen, diesel, or methane.

3. Pyrolysis is a process where the sludge is heated and the carbon is retained in the solid char which is then a fuel source such as charcoal or a soil amendment.

Major advantages of these processes are that they reduce the volume and weight of the material that must be hauled from the plant site to between 5 and 15 percent of biosolids cake, relatively small footprint, and the potential to recover some energy from the exhaust heat.

While incineration is widely used on the east coast and in Europe, it has a negative connotation related to belching black smoke and other air pollutants plus the connotation that it disposes of recoverable materials. As a result, cities such as Palo Alto are moving away from incineration.

Pyrolysis is being researched too, but no really viable design has been developed to use the solid fuel it develops.

Gasification and the utilization of the syngas it produces is the basis of many emerging processes. These include MaxWest, Intellergy, Anaergia, and KORE. The small footprint these processes require, along with the potential to generate excess usable energy, and the reduction of the weight and volume of the biosolids makes gasification processes very interesting.

Other Developing Options – There seem to be new options developing on a daily basis. Two that seem of particular interest are the Anaergia gasification and re-digestion option and Super Critical Water Oxidation by SCFI. The Anaergia process is being demonstrated at the Encina Wastewater Agency in Carlsbad, California. It dries the biosolids, gasifies the dried solids, and puts the high strength water from the gasifier and the syngas back in the digester to reportedly increase the biogas production by 40 percent.

The SCFI supercritical water oxidation process takes approximately 16 percent sludge and pure oxygen to 705 degrees F and 3,205 psi where water is neither a gas nor a liquid and almost complete conversion to clean CO_2, fully oxidized phosphate rich non-hazardous residue, and sterile water takes place.

The MaxWest and KORE gasification systems are not cost effective in smaller sizes and as such are designed for larger agencies and would not be suitable for the Sunnyvale WPCP.

Suggested Implementation Through the Master Planning Process

Co-composting with other green or food wastes at the landfill site should be further explored.

Continue to follow dryer, gasification, and developing technologies and update available information before critical dewatering, beneficial use, or digestion decisions are made. One critical element is that dryers typically require higher solids concentrations in the dewatered cake to be cost effective. In one recent case, 20 percent solids was the minimum solids concentration that could be sent to a dryer site, another case required 23 percent. This dictated that centrifuges be used for dewatering.

Since post digestion processes will generally produce a product that must be hauled off site, a site with easy truck access should be selected if possible.

Follow other regional projects to determine if an offsite option allowing economies of scale to benefit the City.

APPENDIX C – SOLIDS HANDLING CAPACITY ANALYSIS FOR SPLIT FLOW TREATMENT AND PHOSPHOROUS REMOVAL

Appendix C - Solids Handling Capacity Analysis for Split Flow Treatment and Phosphorous Removal

Table 1. Digestion Flow and Load Projections Summary

	Split Flow Treatment		Full Secondary Treatment		Full Secondary Treatment w/ Phosphorous Removal
	2025 ADMML	2035 ADMML	2025 ADMML	2035 ADMML	2035 ADMML
Primary Sludge (thickened)					
TSS, ppd	22000	24000	26000	28000	39000
VS, ppd	20000	21000	23000	25000	28000
TWAS					
TSS, ppd	14000	15000	17000	18000	19000
VS, ppd	11000	12000	14000	15000	13000
Total					
TSS, ppd	36000	38000	42000	45000	57000
VS, ppd	31000	33000	37000	39000	40000
TSS, percent solids	3.5	3.5	3.6	3.5	4.5
Total flow to digesters, gpd	122,000	130,000	143,000	154,000	151,000

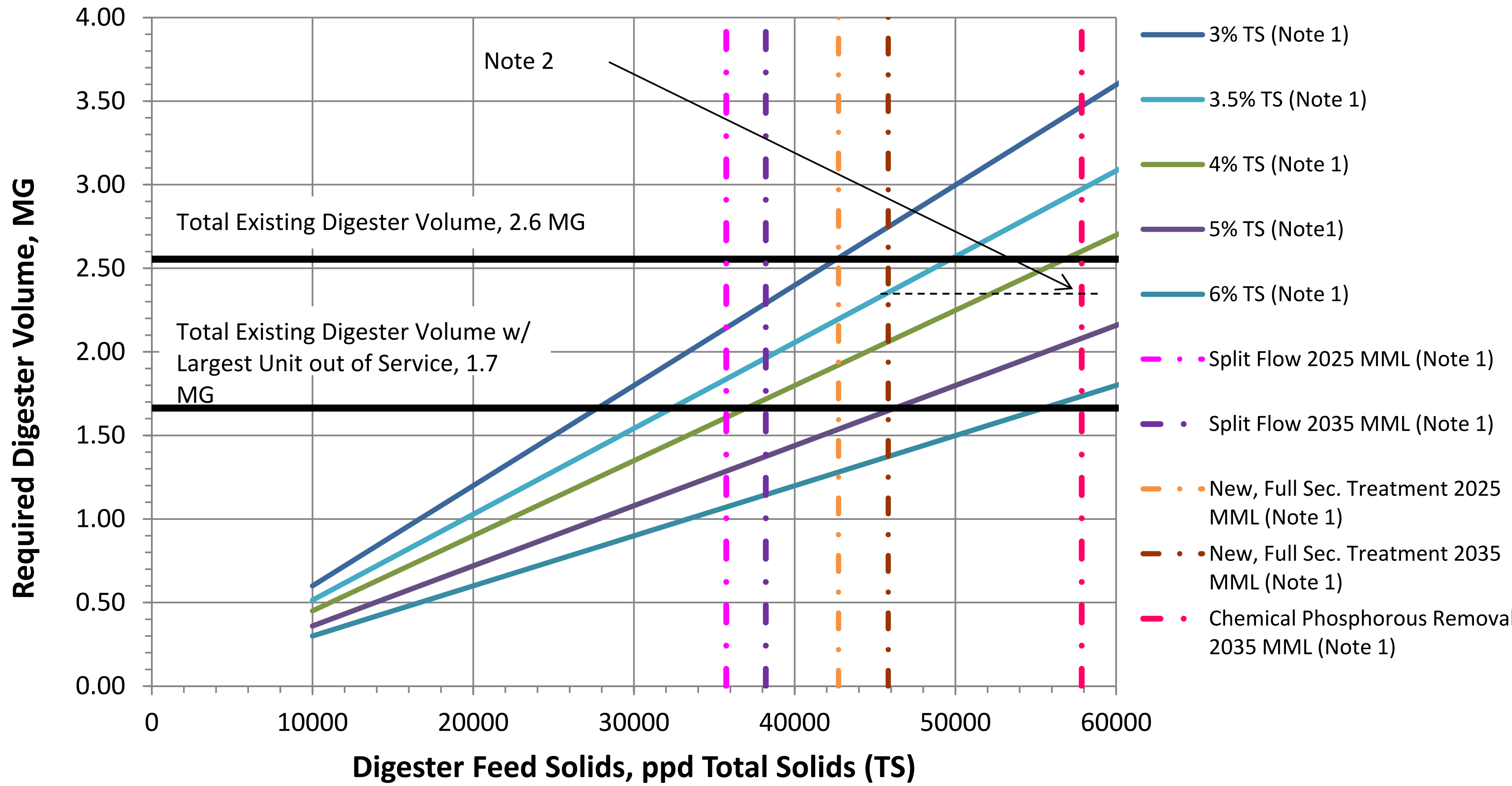
Table 2. VSLR and HRT of Existing Digester Facility at Future Max Month Conditions

	Split Flow Treatment		Full Secondary Treatment		Full Secondary Treatment w/ Phosphorous Removal
Operating Scenario	2025 ADMML	2035 ADMML	2025 ADMML	2035 ADMML	2035 ADMML
VSLR, lb VS/cf/day					
All Digesters in Service	0.09	0.10	0.11	0.12	0.12
Largest Digester out of Service	0.14	0.15	0.16	0.18	0.18
HRT, days					
All Digesters in Service	21	20	18	17	17
Largest Digester out of Service	14	13	12	11	11

Table 3. VSLR and HRT of Future Digester Facility at Future Max Month Conditions

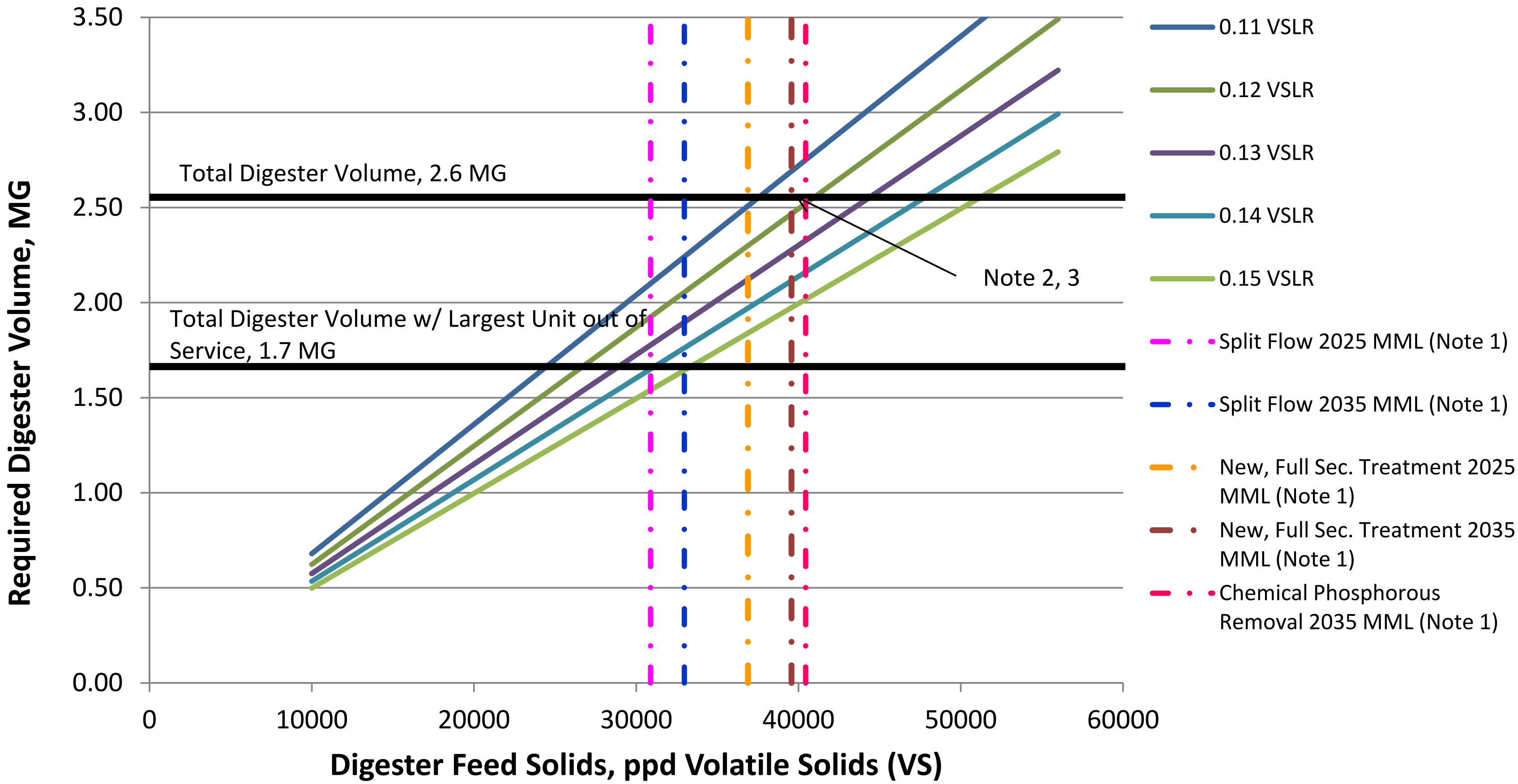
	Split Flow Treatment		Full Secondary Treatment		Full Secondary Treatment w/ Phosphorous Removal
Operating Scenario	2025 ADMML	2035 ADMML	2025 ADMML	2035 ADMML	2035 ADMML
VSLR, lb VS/cf/day					
All Digesters in Service	0.06	0.07	0.07	0.08	0.08
Largest Digester out of Service	0.09	0.09	0.10	0.11	0.11
HRT, days					
All Digesters in Service	30	28	26	24	24
Largest Digester out of Service	22	21	19	18	18

Appendix C - Figure 1
Required Digester Volume for 15-day HRT at Varying Feed Sludge Thickness



Notes
(1) TS = Total Solids; MML = Maximum Month Load
(2) Required digester capacity is the same for "New, Full Sec. Treatment" at 3.5% feed sludge thickness and "Chemical Phosphorous Removal" at 4.5% feed sludge thickness. About 2.4 MG digester volume would be required.

Appendix C - Figure 2
Required Digester Volume at Varying Volatile Solids Loading Rate (VSLR)



Notes:
(1) MML = Maximum Month Load
(2) At a VSLR of 0.12 lb VS/CF/day, about 2.5 MG of digester volume required in 2035.
(3) MML is about the same for "New Full Sec. Treatment" and "Chemical Phosphorous Removal".